HEALTHY HOUSES.

A HANDBOOK

TO

THE HISTORY, DEFECTS, AND REMEDIES

OF

DRAINAGE, VENTILATION, WARMING,

AND KINDRED SUBJECTS.

WITH

ESTIMATES FOR THE BEST SYSTEMS IN USE,
AND UPWARDS OF 300 ILLUSTRATIONS.

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PREFACE.

At length the sanitary Day is dawning. Men are not to do as they choose with their neighbours' lives. They are to be restrained from committing suicide by setting at defiance all the laws of Health. Science is to triumph; and, whilst we cannot be sanguine as to the present generation reaping many of the benefits promised us by the Legislature, nevertheless the accurate knowledge gained respecting the essence of contagion and the skill displayed in innumerable ways in devising life-protecting plans in every part of the British Isles, cannot fail, in the long run, materially to add to the comfort and prosperity of the people, and to lower the rate of mortality. In past ages men experienced the evils of various stages of transition—from the pastoral state, when a few had to brave in rude health the danger of unrestrained and uncultivated nature, to the first traces of commerce, when they combined and travelled for long distances, and, dispersing in bodies, propagated disease as they roamed about, in a manner still common at the present day in Eastern countries. From step to step we have been led to face the difficulties of protecting human life where the largest number had to be fed, housed, educated, amused, enriched, and all in the smallest possible space. Now our large cities are to be rendered safer and healthier than the sparse villages of former times. We do not expect to prolong human life beyond the allotted span, but the largest number possible must attain three score and ten. They are to be protected from baby-farmers and measles, ricketts and consumption, sewer gases and cholera.

Without in any way exaggerating, there is a growing body of wise men who consider that the preservation of the public health is essential in enabling us to hold our own in the rapid race for pre-eminence amongst the nations of the earth. We Ango-Saxons are, and must be, first by force of wisdom, strength, and affluence.

Much that must be known to ensure the bodily strength which is

essential to the highest intellectual vigour, may be learned in tracing the means employed in constructing a healthy home. There is no royal road to sanitary knowledge, but many talk and write on the subject without investigating the laws of physics, or knowing how best to construct a common drain. Who would trust himself in the hands of a self-styled *medico*, ignorant of the properties of castor-oil or opium, and who had never studied human anatomy? We should call such a person a quack, and by the same title can engineers and architects distinguish a host of persons who have lately flooded the newspapers with their suggestions.

Englishmen are very fond of saying that "common sense" should teach us how to protect ourselves and how to build our houses. All I can say is, that few possess the "uncommon sense" necessary to master the rudiments of the business; and facts, not fancies, must be our guides.

This little book is intended as a record of facts—of acquired experiences and published inventions in relation to house construction; and, although the details may appear dry to the many, I have written under the impression that they were essential to the annually increasing number of persons driven to build houses, or to remedy the defects of those built for them by others. If I appear to have treated anything in a flippant manner, it was far from my intention, for I am too well aware of the importance of the subject to willingly transgress in this way.

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The Author may be consulted upon any of the subjects mentioned in this work at the rate of One Guinea for each consultation, if in London or its immediate neighbourhood. If his services are required in the country, his fee is Five Guineas per day and travelling expenses.

CONTENTS.

FOR INDEX SEE END.

CHAPTER V.

CHAPTER VI.

CHAPTER VII.

CHAPTER VIII.

CHAPTER IX.

CHAPTER X.

CHAPTER XI.

CHAPTER XII.

CHAPTER XIII.

CHAPTER XIV.

CHAPTER XV.

CHAPTER XVI.

HEALTHY HOUSES.

CHAPTER I.

INTRODUCTION.

A RESIDENCE in which unhealthiness reaches about its *maximum*, may be said to be one which is built on a damp site with higher ground behind pouring down its waters against walls without areas—walls innocent of a damp proof course to arrest the rising wet—and walls, likely enough, also exposed by insufficient thickness to driving rains. It may be in the neighbourhood of low-lying fields, undug, unditched, undrained, or with the tiles long since choked up. The rooms throughout are low, with a haphazard ventilation, insufficiently furnished with windows, and with perhaps too many doors. The main staircase is without a lantern vent, or the wall there is pierced by a window not sufficiently high to empty the gasometer overhead. As for the back-stairs, the basement smells climb them *en route* for the dormitories. The chimney flues are also badly constructed, and a smoky atmosphere is all but constant. Overcrowding lends its quota of evils—as press-beds in every available corner testify. The drain pipes are injudiciously laid inside instead of outside the basement, with leaky joints owing to indifferent luting, and with pipes broken where they pass through the walls, owing to continuous settlement. A foul soakage of the soil around the unpuddled pipes speedily follows. The lead-work is also defective, dishonestly executed with thinnest material, badly junctioned to the drains; or if once properly performed the maintenance of that state of things is neglected from ignorance or parsimony. The water pipes, too, are all built in the brickwork or buried deep in plaster, a burst pipe soon causing the walls to resemble a huge sheet of wet blotting paper. As for the sinks they are far too numerous, and made to perform improper *services*. The scullery traps have long ago lost their gratings,

and are filled up with grease or other refuse. Upstairs the waste pipes of the lavatory and of the bath are connected direct with the sewer. There is, moreover, only one cistern for the multitudinous necessities of a family. The closets supplied from this same cistern stand directly in the passage and have only one door; the apparatus is faulty, and the hidden soil pipe is somewhere imperfect. Ventilation of the drains there was originally none, and none is contemplated; the accumulated gases therefore take the water trap by storm and invade the atmosphere of the house. Even the flushing of the too flatly laid house drains is unattended to, or left to the periodical downfall of rain through the rain water pipes, which only serves to stir up the nuisances, not carry them resistlessly away.

If the mansion is situated in the country there are, perhaps, no drains to flush, no sewers to ventilate; a cesspool instead receives elemental downpours, household slops, culinary waste, closet excreta—everything. Moreover, there is no overflow therefrom, save into the surrounding soil. Perchance the house is an ancient one, and connected with old brick sewers, the bulk of them rotten, and harbouring vermin who gnaw their way into the rooms, and let in upon the inmates the continually evolving gases of the underground tunnels. These again may drain into some gigantic pit or series of pits hidden in the grounds, or they may debouch into some festering or open ditches in the meadows below. If newly-laid drains convey the *effete* matters into a sewage receptacle with a view to utilization in the garden, in all probability they are choked up, and an accumulation ensues which, by and bye, ruptures every joint. Of course the tank is not ventilated, and the compressed gases blow through the traps, tainting the very milk in the dairy. The water is in a worse plight, the supply is contaminated and unfiltered, the waste pipe of the leaden cistern connects unapologetically with the sewer; in other words, there is not even a trapped overflow. Or the household may be dependant upon a well, the yield of which is nauseous from the infiltration of sewage through a porous soil.

The above is, after all, but a poor epitome of the evils which begird an insalubrious home. There are within the postal circles of every city and town of Britain thousands of houses fairly representative of every source of mischief here set forth. Besides, the foregoing are *but generic errors,* and not a blunder is there exposed, but drags in

its own *specific* germs of mischief, the least of which may grow to be subversive of human life. It is not for me, however, to speak of the dread guests which such a state of matters invite; that is the duty of the physician. Neither need I enter upon the question of difference between infection and contagion—that *pons asinorum* of the sanitary Euclid. This is the province of the State pathologists, and I could only echo their teachings.

How different to the above is the house which Hygiene, the health goddess, delights to honour. Natural surroundings which never could have been pleasing to her have been coerced into propriety and order. The stagnant pool has been filled up, the morass has been thorougly drained. The building sits dry as an Eastern house on the hill side. The rooms are lofty, the passages airy, and a cheerful light permeates every corner. The foul witch, bad air, should she make a passing call is whisked up the chimnies and other outlets almost before she has announced herself to the vigilant inmates. Pure fresh air on the contrary is everywhere a cherished guest, and in return she acts like a most beneficent fairy. The main sewers invite rather than repel scourage, are duly ventilated, and a suitable disconnection is made wherever possible between these and the drains of the house. The water, too, is well chosen, the cisterns are sufficient in number, efficient in working, and both hot and cold water supplies are easy of access.

The closets are built one over the other, in a separate tower, with well ventilated vestibules. The offices, the stables, and all other accessories bear witness to the same clear-headedness on the part of the constructor. The Useful has been made Beautiful, not the Beautiful partially made Useful.

As I aim at, to begin with, a practical exposition of the effects of bad drainage, I will now quote out of my practice for the past few years two short examples of these evils. In both cases the drainage was chiefly deficient, but it must not be forgotten that this in itself constituted a legion of evils. When standing upon the platform of the Drainage Question one shoulders, so to speak, on each hand the kindred subjects of ventilation and heating. It follows that the necessary adjuncts to good health, as far as the residence itself is concerned, are alike restricted in number—pure water, fresh air, a proper *temperature. These* almost monopolise the subject.

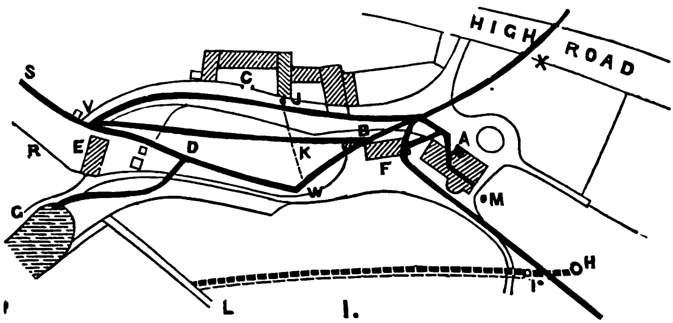
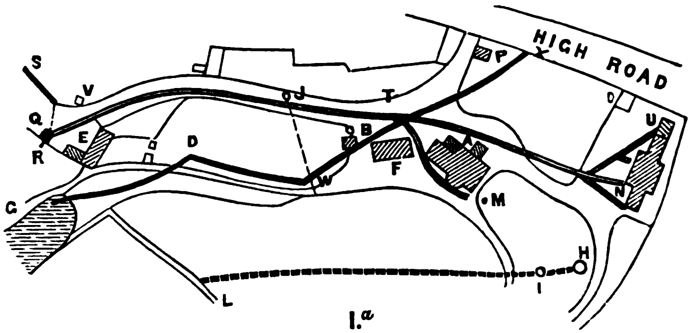


Fig. 1 is a plan to a scale of 25 inches to a mile of the residentiary portion of an estate in the northern suburbs of London, as it existed previous to alteration. The thicker lines represent old brick drains, and it will be observed that the house was connected with a perfect net work of these round and square burrowings. In ordinary weather the drainage found its way to the lowest point at S, and thence ran down an open ditch riverwards. In very wet weather, the excess of the more liquid portion was conveyed into the fishpond G. At A was formerly a large cesspool, about 8 ft. square and 6 ft. deep ; and, on cleaning it out, previous to its abolishment, accident brought to light another cesspool semewhat shallower immediately underneath, the builder, doubtless, thinking somehow to minimize the nuisance in this way. The stable, coach-house, and piggeries at C were drained by an offensive open channel into the centre of the farm-yard. The ice-well at H was drained into a secondary well at I, and this ran by way of the clean open watercourses and to the fishpond. This last-mentioned was the solitary approach to a wise system of drainage. To proceed with our description, the house was supplied with remarkably hard water from a spring well at M. The cottage at J was supplied from an adjoining well, and a pump for soft water was also in use at B. On one occasion, when the water from the well at J was found to smell offensively, it was cleaned out, and independent of soakage from the defective brick drain, immediately beside it, a number of putrid moles were discovered in its mud. These had found their way into the well through the displaced joints of the

overflow pipe. Nor did the mischief end here, for this same overflow pipe emptied itself into a brick sewer at K; the sewer, therefore, ventilated itself into the well. During sudden storms the overflow arrangement was reversed and the sewer returned the compliment by overflowing for a brief space into the well.



I.ª

The above arrangements of course proved intolerable to a sensible purchaser and alterations were made which are set forth at Fig. 1*a*.

First of all the stable buildings were removed to U, and on the site of the old cesspool at A a water closet tower of three stories was built, having large water cisterns on the top. New drains of glazed earthenware pipe were also laid in, running from the new stables at U to the sewage tank at Q, and picking up the house-drains from A and the cow-house drains from E on the way. These are shown by the double line.

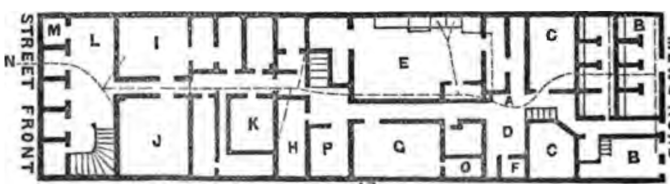
No connection was made with the old brick drains, although for some distance, as will be seen by comparing the two plans, they run in twin directions. When the neighbouring hamlet, however, was drained into a new sewer, the drain from the high road received only the overflow of the gully traps along the kerb, and this water was utilized and followed the old drain—shewn on this plan by a thick line—to the pond at G. The sewage tank at Q was built in two compartments, the outer one being connected with a pump. The overflow of this tank was carefully attended to, and it was also ventilated by a stand-pipe, as were the drain-pipes at several places, and the whole

of the soil-pipes. The new lodge at P was supplied with an earth closet.

With reference to the water, The Water Company's supply was laid on to the house and stables throughout, and the wells at M. B. and J. were thenceforward only used to moisten the flower beds. As for the rain-water, it was carefully collected at both house and stables into separate tanks.

This was wholesale treatment, and ameliorated affairs considerably, After a year's trial, however, it became evident that there was still some radical defect in the drains, and it eventually proved that the scullery sink had not been cut off from the old drains, the consequence of which was that the kitchen refuse water found its way into the whole of the old system of drains as far as D (see Fig. 1), and as the connection between D and V had been interrupted in years gone by, the waters of the fish-pond soon became black by the action of the scullery water and the scouring of the old brick drains. Rats also made their way into the house, and stench unbearable followed them, from their head-quarters near the conservatory at F. I broke into the drains at several places, and, though scarcely creditible, a navvy's shout down an opening at J (see Fig. 1), was audible not merely at V and W, but as well at F, D, and G.

To remedy matters, the scullery drain was diverted into the modern pipe drains. The old brick sewer, from P to G, was scoured out as well as possible, and was isolated entirely from the others. Altogether upwards of a thousand feet of obsolete shapen brick drains or sewers were shut up and abandoned, and when this was done a cure was effected.



1.b

Even in cities great evil is occasioned by these old drains of brickwork, and to illustrate this I give, at Fig. 1*b*, the basement plan of a *nobleman's house in Belgravia*, where the smell having become in-

sufferable, owing to the rotten state of these drains and the consequent soakage, the brickwork had to be broken up, and a large glazed drain-pipe laid down. The brick drain ran from the stables at B, through the laundry, C, and kitchen, E, on to the main sewer at N, a distance of 150 feet, and smaller square brick drains communicated with it as shown. During the substitution of the one class of drain for the other, from C onwards, I discovered a large cesspool at A, a cesspool without even an overflow into the adjoining drain. The scullery floor and sink both drained into it, and as this pit was also connected with a rain-water pipe in the corner close by, I was able to account for a great deal of the stench which found its way over the intermediate lower roofs into the reception rooms above K. The sinks in the housekeeper's room, J, butler's room, I, and footman's room, O, were fitted with the old-fashioned bell-traps, and most of these having lost their sealing powers, the smell pervaded more or less the whole of the basement, especially the servants' hall, G. The traps in the open courtyards, D and P, were also defective, and the effluvium stole by this way into the bedroom windows. At the same time the overflow-pipes of the cistern carried the smell into the two staircases. After clearing out and filling up the cesspool at A, fixing self-sealing traps in the sinks, the courtyards, and cisterns, and ventilating the new drain-pipe, I rendered the mansion wholesome.

I have met with worse instances than the above, but these will serve to illustrate a few of the ordinary sources of evil. The medical residents in a town or city are for the most part alone cognizant of these, and their experiences have very often begun at home. When they, however, encountered the first foul smell, or heard of the first inroad of rats after renting or purchasing the house, they took up the basement floors, and I know that in three cases out of five a filthy cesspool was revealed or an obstructed drainage laid bare. The nobles, the merchants, and the numerous other classes of residents would doubtless find enough to remedy, were they to institute similar researches.

The following chapters will enter more into detail, and will, it is hoped, prove a guide to a clearer knowledge of sanitary matters. To render the work a complete one, a short history of the various appliances will also be given. It is not sufficient to know the names and the prices of the *best systems* now in use, a knowledge of their *construction should also* be mastered. This is too often left to the architect

alone. The occupier, however, as well as the designer and builder of a house, should have some guide to the methods whereby the air of a room may be rendered wholesome and the drainage and water supply kept in healthy control. Moreover, we do not all live in cities, or can command skilled labour at will. I will therefore furnish sufficient information whenever possible to enable the reader who has not studied these matters before to carry out his own ideas, when happily he dreams wise dreams and imagines good things; or when, unhappily, he is caught at a disadvantage by some hostile "power of the air." Promptitude, too, in dealing with impurities, is a great matter. If Mr. Rawlinson had waited for metal or other flaps from England to fit to the sewer mouths at the Bosphorous hospitals during the Crimean war, and had not improvised the leaded canvass flaps, the use of which, in less than three months, notably decreased the death rate from 50 per day to less than 10 per week—how culpable he would have been. The late Mr. Brunel acted in the same alert manner, and I have laid in Asia Minor thousands of feet of wooden box drain, coated inside with pitch, just as sent out by him in the hottest haste.

CHAPTER II.

DRAIN PIPES AND DRAINING.

DRAIN PIPE MATERIAL.

UNDOUBTEDLY made of hollow trees in the early ages, drain and water pipes soon began to be constructed in clay, and burnt; for we have dug up at Illium Novum terra cotta pipes that are claimed to have been laid before the time of Xerxes. The race for novelty or economy, however, soon produced several substitutes for clay. Glass pipings were broached in 1845; and in 1857, Messrs. Turner introduced a system of casting drain pipes of block glass, to which no objection can be raised beyond that of expense.

Twenty years ago sewers and drain pipes in segments of cast iron were proposed, but they did not make head against clay pipes, owing to the cost of bolting and luting the joints. As far back as seventy years ago, what was called Tatham's clumps, were manufactured for forming the larger drains. These consisted of segmental pieces of clay or stone, forming a circle, with broken joints and key pieces to hold them together. Some sewer blocks were also invented by Mr. Tooth, in 1855, with a novel system of curvature; and soon afterwards were introduced the invert blocks now so common.

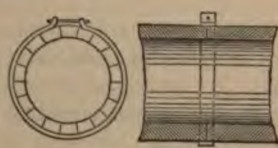
It has several times been proposed to construct the drain, sewer, and other pipes of concrete; but in 1852, there was projected a system of building them continuously without joints, in about equal parts of hydraulic lime, sand, and powdered sandstone, upon a revolving metal core. Soon afterwards, Mr. Blackburn proposed that the socketed pipes of large diameter should be made of slates laid in a cylindrical form in a matrix of asphalte, the slates being bound with hoops, set erect, heated to 300 degrees, and the fluid asphalte then poured on.

In 1860, the production of drain and other pipes of broken stone or flint, united by some suitable cement, was patented by Sir J. Scott Lillie. Mr. Hargreaves afterwards suggested powdered chalk, lime, slate, or sand, mixed with melted bitumenous matter. A siliceous stoneware was also projected by Mr. Ponton, made of ground flints or quartz added to as much melted sulphur as would render the mass

compact. Machines for boring stone, and so forming drain-pipes, followed this innovation; nor did invention seem to rest until 1868. In that year Mr. Robins took out a patent for pipes formed of oakum and cordage, cemented with asphalte or pitch, outside and inside, and dusted afterwards to keep off the sun.

We have seen that pipes were originally of wood; but just as science will sometimes revert to her first schemes, so wood is now once more in favour.

In some of the American States, drain-pipes of timber are preferred to any other kind. Some of the lands there are drained by pipes made of the most perishable woods, but subjected to the vapour of carbolic acid, or preserved on the Robins' principle, before being laid in the ground. Such drain pipes cost about a fourth-part the price of drain tiles.



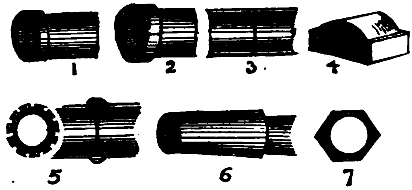
1.

Some monster wooden drainage pipes, 3 ft. in diameter, built up in segments, 3 in. thick, and in 24 ft. lengths, 6 in. wide, have lately been manufactured in Gloucester. The joints are made with bands of iron 3 in. wide, tightened with a screw bolt, and these bands also occur every four feet. They are intended by the inventor, Mr. Harper, of Merthyr, to rest upon stone piers of great height, and are to carry the sewage of that district across gullies in the hills, where iron syphons would be too expensive. If the sewer was to be laid in the ground, 36 in. glazed pipes would of course come much cheaper. A sketch of this peculiar drain is furnished at Fig. 1.

The drain-pipes of the present day are, however, mostly of earthenware, made in various parts of the country, and especially in Dorsetshire, Staffordshire, and Yorkshire. The market around London is chiefly supplied from Lambeth; whilst the neighbourhoods of Newcastle and Edinburgh are each the centre of a large trade. In London, what is known as pipe-clay is used, and the pipes are glass-glazed, but in the majority of other places half pipe-clay and half fire-clay is worked up, and the pipes are salt-glazed. Sometimes one system of glazing is preferred and sometimes the other. I advise the reader to be content with the kind of ware made nearest him, provided that the pattern itself meets his requirements. Both kinds of material are sufficiently good, and if well burnt and well laid will last for a century.

Unless otherwise mentioned, glazed ware will be alluded to in these papers.

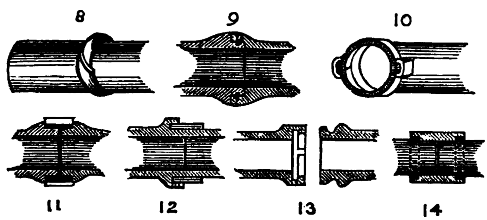
FORMS OF DRAIN-PIPES.



The different forms of pipes are here shewn:

Fig. 1 is the ordinary circular socket pipe, and Fig. 2 has a similar joint, but is egg shaped in section, and recommended in particular cases. Fig. 3 represents the ordinary butt-jointed pipe, which was once used in drainage through stiff clay, and in cases where there was no danger of infiltration. It is now only adopted in field drainage. Fig. 4 is a new retort shaped pipe, lately made by Messrs. Brooke & Son of Huddersfield. The fluted pipe Fig. 5, was proposed by Mr. Creeke, an architect, of Bournemouth, who considered this shape would yield additional strength without adding to the weight. The joint of this pipe is made with a metal ring fitting the groove and bedded in red lead, and two clamps ingeniously inserted on the outer circumference draws the pipes in perfect contact. Fig. 6 is a taper or conical pipe. The ends fit in so far that a settlement of the ground is less likely to disconnect them; they also curve better, but I cannot recommend them. Fig. 7 exhibits a pipe proposed by Mr. Austin in 1854, on the principle that they would sit better in the soil and pack together without loss of space. But very few of them were manufactured.

JOINTING OF PIPES.

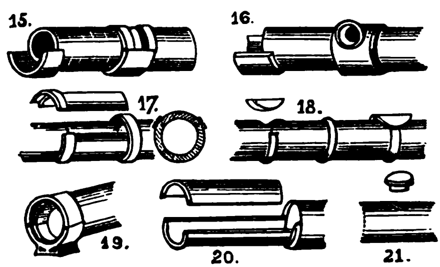


With reference to the jointing of these pipes at Fig. 8, may be *noticed what is called* the half-socket pipe, and this is a form very

extensively used. Fig. 9 represents a pipe which I draw merely to condemn; it was proposed in 1848, and the key of the rebate was formed by the pouring in of *melted gutta percha.* The joint shown at Fig. 10 was, I believe, the first of the sort called dovetailed, but it has many disadvantages. The systems shown at Figs. 11 and 12 have been used in Lancashire, and have their merits. Fig. 11 is called the fast socketed joint, and Fig. 12 the double shouldered joint. The saddle of Fig. 12 is formed in two parts, so that when the top one is removed the joint is at liberty. The pipe Fig. 14 is simply Fig. 3 fitted with a sleeve piece, with recesses in it, to receive a cement packing. The other plan, Fig. 13, is called the lock-jointed pipe. and is shown applied to the common socket pipe. Mr. Creeke, the inventor, prefers the pipes made with this joint to be of an uniform thickness, for the sake of strength and facility of manufacture, and for the more uniform bearing throughout its length. I question if it will ever become a favourite.

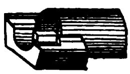
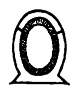
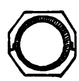
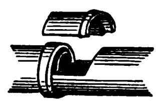
It is only eighteen years since pipes, giving an easy access for the inspection of their contents have been introduced. Previous to this the joints were all socketed dark and fast underground, and the drains were sealed to all interference except that which necessitated destruction. Now, however, many architects specify the drains to be laid throughout with these pipes. Others are content with every fifth or tenth pipe affording means of examination. This should occur only in the grounds, and never inside the house.

ACCESS PIPES.



Figures 15 and 16 are pipes manufactured solely by Mr. G. Jennings, of Westminster. The weight of pipes and contents rests on

the sockets, and the removal of the saddle covers admits of a thorough overhauling. Fig. 17 is the patent opercular or lidded pipe of Messrs. Doulton and Co., of Lambeth, and here the entire length can be thrown open, and the joints remain undisturbed. The covers are fixed in one piece, and when in the pipe, thus securing a perfect fit. Fig. 18 represents Mr. Creeke's patent capped drain pipe, made by Messrs. Standing and Marten, of Poole, Dorsetshire. This construction gives to every part of the joint the security of a socket or flange covering it, and is an excellent device. Fig. 19 is the improved registered drain pipe of Messrs. Stiff and Sons, of Lambeth, and differs from the others by having a broad firm base to the bottom chair, and a good rebate in both chair and saddle cover in which to bed the pipes. The plan shown at Fig. 20 is one of the patent arrangements of Mr. Northen, also of Lambeth, a V shaped joint running along the whole pipe. The last, Fig. 21, is the patent improved capped pipe of Mr. Newton, largely made by Messrs. Cliff and Son, of Wortley, near Leeds. Most of the above systems permit of junctions being formed in the chair and saddle, as shown to the right of Fig. 16, but all have due provisions made for this purpose.

22 23 24 25

Besides those which we have just explained, and which are usually sold, I ought to notice the interlocking joint of Mr. Cooper, of the Isle of Wight. The saddle is also left unglazed, to assist the cement in forming a tight junction. Fig. 23, the invention of Mr. Livingstone, of Portobello, is a pipe having a hollow cradle rest with cover above, and with an aperture formed in the top of the drain. Fig. 24 is by the maker of Fig. 22, and consists of a coupling piece in two halves, united by an inclined dovetailed joint, so as to slip on and be afterwards drawn tightly home. The last system of a pipe with an opening, which needs remark, is Fig. 25, invented by Mr. F. Kersey, of Southwark, in 1856. Its merits are obvious.

Long bamboo canes and jointed sticks are often used for cleaning out small house *and stable* drains, and should be at hand in every

establishment. Drains of a larger calibre are cleared in a similar way, but need a rather more elaborate contrivance. Mr. Birch, in 1862, proposed universally jointed rods, fitted up with rollers, which, when moved backwards and forwards, loosened the solids in the drain bottom and permitted a complete scouring. If any material, subject to matting together, such as hair or straw, had effectually stopped up the pipes, this was removed by the action of a screw at the end of the furthermost rod. Most of the London builders are provided with rods of this description, but only use one anti-friction roller, and this at the extreme end of the screwed-up series. In sewers properly so called, where personal access was impossible, and breaking up the ground unwarrantable, something still stronger than the above is requisite. Messrs. Fricker and Manley, in 1861, constructed an instrument formed of a bar of wood, with numerous blades fixed on its length in the plane of the thread of a screw. A series of these swivel-jointed, were dragged through the sewers, by which means the sediment was agitated and beaten up, and preparation made for a thorough flushing.

I will now notice the various shaped junctions, bends, and syphons which are used with glazed earthenware pipes.

JUNCTIONS, BENDS AND SYPHONS.

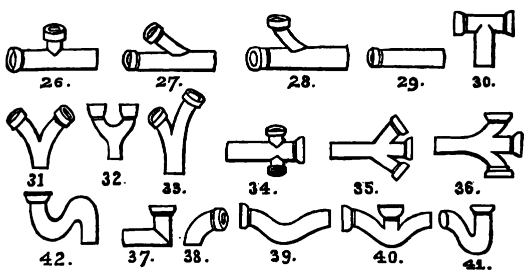


Fig. 26 is called the square single junction, Fig. 27 the oblique single junction, and Fig. 28 the curved single junction. They can be ordered by these names without any fear of mistake. The T-shaped junction Fig. 30, the Y-shaped junction Fig. 31, and the U-headed junction Fig. 32, are those used in diverting the heads of drains or in collecting two drains into one channel. The tapered pipe, Fig. 29, simply reduces a large-bored pipe to one somewhat smaller; Fig. 38

exhibits what is called a shaft top, the shaft bottom resembling in shape Fig. 38, the use of these in brick and other built up drains and sewers is obvious. Fig. 34 is called a double square junction, Fig. 35 a double oblique junction, and Fig. 36 a double curved junction. The different curved bends and elbows have to be ordered according to the sweep which they follow. Fig. 38 represents a quick bend. The square elbow Fig. 37 is, in its contour, invariable. As for the syphons, Fig. 39 depicts a syphon pipe without an inlet, Fig. 40, one with an inlet, Fig. 41, what is called a close syphon, and Fig. 42, an ordinary closet syphon.

The undermentioned prices are prices for the pipes inlaid and are subject to discounts varying with the place of delivery, but this information can be best obtained at the manufacturers. The cost of laying complete can be ascertained from the nearest builder, and of course is regulated by the depth at which they are laid.

PRICES OF DRAIN PIPES.

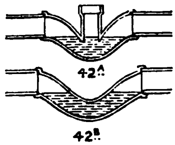
Diameter of Pipes in Inches	PATTERNS OF PIPE, AND PRICE PER FOOT RUN.														
	1½	2	2½	3	4	5	6	7	8	9	10	12	15	18	24
	d.	*d.*	*d.*	*d.*	*d.*	*d.*	*d.*	*d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d*	*s. d.*
No. 3	2½	3	3½	4	1½	5½	6½	8	11	1 0	4 5	1 8	2 9	3 8	...
Nos. 1*a*, 8, 18, 19, 20, and 21	3	3½	4	4½	5	6	7	9	1 0	1 1	1 6	1 10	3 0	4 0	6 0
Nos. 15, 16, and 17	...	...	...	5	6	1	8	...	...	1 1½	...	1 10	3 0	...	...

The oval pipe No. 2 is somewhat more costly than No. 1*a*.

PRICES OF JUNCTIONS, BENDS, AND SYPHONS.

	DIAMETER OF APERTURES IN INCHES, AND PRICES EACH.						
	2	3	4	6	9	12	15
	s. d.	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*
Single Junctions, Nos 26 to 30	0 7	0 8½	0 10	1 2	2 1	3 3	5 6
Double Junctions, Nos. 31 to 36	0 9	1 0	1 2	1 7	2 8	4 4	8 4
Bend, Elbows, &c., Nos. 37 and 38	0 8	0 10	1 0	1 4	2 1	3 3	5 0
Syphons and Traps, Nos. 39, 41, and 42	1 2	1 6	2 1	3 0	4 6	7 3	...
Syphon with Inlet, No. 40	1 8	2 0	2 7	3 6	5 0	7 9	...

Earthenware disc plugs are made and sold for insertion in these junctions, &c., when drain pipes are so fitted, with a view to the reception of the continuing drains at some future time, and these cleanly contrivances range from 4in. to 15in. in diameter, the prices being about 1½*d.* for the smallest sized and about 1s. for the largest sized disc.



42 a.

42 b.

To revert for a moment to Figs. 39 and 40. I ought to point out that these are sometimes sadly abused. For instance, the former when laid in a drain, should resemble Fig. 42 *b*, and just exactly trap and no more. If too deep a syphon is used, it will speedily fill with sediment, as thousands of householders can testify to their cost. If Fig. 42 *a* is used, the top should be especially well covered, even after the glazed disc plug is in. As a rule, I should rather rely upon the flap-trap in the main sewer than upon either of the patterns.

DRAIN-PIPE LAYING.

The laying of drains *through* the basement of a house should be avoided. They ought to run outside the house, and permit of a ventilating chamber into which the small pipes from the house can deliver. Cases, however, will occur where this becomes impossible, for instance, when large town mansions, such as the one depicted at Fig. 1*b*, page 6, are joined together in streets and squares. Whenever a pipe-drain *is* laid inside the house, whether it be the main drain which is to be connected with the sewer, or a tributary drain leading from a sink or closet to the external drain, the pipes should be laid on a bed of concrete, and, as the joints are properly made, covered over with about twelve inches thick of the same material. This will insure a perfectly air-tight and water-tight drain. Good ground lime concrete will serve the purpose, but I should recommend concrete made with cement. Elsewhere, outside the house, the pipes should be laid in a trench impervious to water. If the ground is clayey this will be inexpensive, but if light and earthy, or sandy and gravelly—and therefore porous—it will form a larger item. Nevertheless it should be done, at any cost, the pipes laid on a bed of well worked clay-puddle, and as fast as the cement joints are made covered over some inches deep with the same material. Where the pipes pass through *made* or new ground, especial care should be taken to bed them upon concrete which should extend to the bottom; but if the hard, natural surface is at a considerable depth, a series of rough piles might be driven to a foot below the level of the drain bottom, and a 12-inch concrete bedding made for the pipes to rest upon.

The *most careful* supervision is needed in house draining. It has

frequently occurred that pipes too small in diameter have been supplied, that the pipes have not been laid to proper fall, that the joints have not been made with either cement or clay, and the unshouldered ends simply pushed dry into the sockets. Nay, even faulty pipes, and lengths which have been broken asunder in the transit, have been buried, before now, in unprepared trenches, through sheer carelessness or ignorance. Sometimes the cement for joining sent by the builder has been misappropriated by dishonest labourers; and the fact cannot be blinked, that sometimes the builder, equally deficient in conscientiousness, has omitted the puddling, owing to the dearth of clay in the neighbourhood, and has put in the ballast of the concrete without lime, or omitted the concrete altogether.

In houses built as a speculation by the poorer class of builders the above faults are but too common; their money has, in fact, been made to spread over a space of work too huge for it. Too often the drain-pipes of a house are laid in before they have been inspected by architect or proprietor. The architect has only furnished the plan, and the amount of work to do will not justify the appointment of a clerk of works, and the owner does not care to pay a visit until there is something above ground "worth looking at." Sometimes the builder himself has never examined them; the work is probably at a distance from head-quarters, and, pending the arrival of an appointed foreman from another contract, the laying of the pipes—one of the most important items in house architecture—has been entrusted to a humdrum labourer.

In planning the drainage to a new residence or offices, it is advisable to provide a few junctions at divers places where they are likely to be wanted, for the expense of disturbing the larger pipes after they are once well laid, especially if bedded in concrete, is very considerable. The orifices of these dummy junctions should be stopped up with the disc plugs previously mentioned, or with some sort of well-fitting solid core. These junctions should never be right-angled, as in Fig. 37, or the drain anywhere turn in any such abrupt manner; and where either junction or bend is used in order to counteract the effects of friction, an extra dip should there be allowed to the drain. The inlets ought to be especially protected by concrete or good puddling. Moreover, the larger tributary pipes which branch into the main pipes should not be *of the same bore* as the latter, but diminish by three

inches—12-inch into 15-inch, 9-inch into 12-inch, and 6-inch into 9-inch pipings. The lesser drain-pipes will diminish by two inches—4-inch into 6-inch and 2-inch into 4-inch pipings. By this provision the soil is less likely to blockade the passage mouth. The diminishings should, furthermore, be made by the tapering pipes sold for this purpose.

The dullest student of Hygiene would at once acknowledge that the lowest portion of a house should be drained, but it is not unfrequent to find some underground rooms which are not so—notably, when the kitchen and scullery, to which level only the pipes are laid, are some steps higher than the dairy or the knife-room. Each room should be connected to the drains, even the wine and coal cellars. To accomplish this, however, the proper fall of the drain must not be lessened. To save the expense of deep digging, a fall of less than an inch in ten feet is often given, instead of two or three inches in that length. An inch in every ten feet of pipe is the least that can be recommended, even with the best flushing supply. There is such a thing, however, as giving too much fall. This could not happen where the outfall was into the main sewer of a town, but if the pipe led into merely a somewhat larger pipe, it would simply fill up like a long and narrow sack. It often happens, too, that the drain-pipes, where they pass through the walls are broken by settlements or during the consequent underpinning. To lessen the danger of this, relieving arches should be turned over the pipes, and any other security taken which may offer. I have known both the surface water from a roadway, and the waste water from a house sink to find egress at a rupture of this description, and soak into the foundations for months before the mischief was discovered. Another matter of great moment, is the effectual flushing of the drains, and this should be performed at least every month. If no better means can be found, the rainwater may be collected in underground tanks and be discharged by means of a hand engine into the pipes. An efficient scouring not only removes obstructions which may have formed, but it sweeps away a dank fungoid vegetation, which sometimes forms at the water line. An incompetent flushing may merely mass a series of obstructions into one.

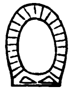
There is one thing which the owner of a house should always insist upon receiving from his architect or builder, and that is, a correct *drainage plan,* with the different sized pipes, the position of bends

and junctions, and the depth from the surface carefully marked on. I would even make it compulsory for a landlord to furnish such a plan, on granting the lease of a house, and to enable him to be correct, I would almost make it penal for the tenant, even on a building lease, to divert or add to the drains without furnishing the landlord with a plan, showing the altered or added line of pipes. These plans should be certified as correct by both parties; they should not resemble the plan of the drains sent to the local authorities by the builder, *before he begins the work*, which, *in scores of* cases, would bear no resemblance to a plan of the drains *as finally executed*. On a large estate also, it will be found wise to supplement the notes as to position and depth by some information as to the geology of the cuttings, for I have seen on the same level pipes laid in a bed of re-assorted Bagshot sands on one side of the house, and in stiff London clay on the other.

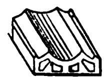
CHAPTER III.

INVERT BLOCKS, BRICK SEWERS, SPECIAL PIPES AND SEWAGE TANKS.

INVERT BLOCKS.


43.


44.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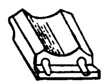
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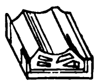
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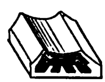
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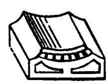
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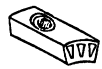

50.

THESE useful articles have been manufactured for a comparatively long time, and are used in the construction of circular, oval, or egg-shaped sewers, and form the invert as shown in Fig. 43. Where brick-drains or culverts are necessary, they are most valuable. They are of various kinds, Fig. 44 being what is called the plain invert; Fig. 45, the lipped invert; Fig. 46, the rebated invert; and Fig. 47, the socketed invert. These vary only at the joint, as will readily be noticed, the variation in the hollow spaces of the block being of no consequence. Nearly every maker has his own pattern, and these last-mentioned four represent those constructed and sold by Messrs. Brooke and Sons. A good patent invert block, sold by Messrs. H. Doulton and Company, is shown at Fig. 48; and at Fig. 49, is seen another improved block, sold by Messrs. G. Jennings. These inverts are made to suit sewers of all widths, from one foot upwards, and are made to accommodate rings of brickwork four and a half inches or nine inches thick. Junction blocks are also made to build in with the brickwork of the rings with sockets cast in them to receive the *draining* or flushing pipes and an example is shown at Fig. 50.

PRICES OF INVERTS.

MEASUREMENTS.			
Across Top.	Across Base.		
ft. in.	ft. in.		s. d. per foot run.
0 7	1 2	For 4½ in. work	1 6 "
0 7	1 9	" 9 "	2 0 "
1 2	1 9	" 9 "	3 0 "
0 9	2 0½	" 9 "	4 0 "

The above prices ought to include delivery.

BRICK SEWERS.

The best form of brick sewer is the egg-shaped one, which may be popularly described as an upper circle resting over a circle below of half its diameter, and with the spandrils rounded. In the *Suggestions relative to Sewerage*, prepared by Mr. Rawlinson, pursuant to the Local Government Act, sections of all the different sizes are given, along with the prices given on our next page. These brick sewers as a rule are now rarely built, save for main drainage purposes in which case the parish and other authorities would supervise them. Circular and oval, as well as egg-shaped tunnels are, however, sometimes used for culverts, even on small estates, and therefore require a notice. In the introductory chapter I exhibited the sad decadence of the brick sewers, built, say twenty-five years back. It would appear from an inspection of some of them that no attention was paid either to the materials or workmanship. The worst and the softest bricks were utilised out of sight—were laid in dry and badly grouted just afterwards. The consequence is that the earth around them is as sodden as would be a biscuit thrown into bilge-water, and the dangers which they may give rise to when the joints of the stone paving open, or the tiled floors wear loose, can hardly be over-estimated. I have no hesitation in saying that all the old brick-drains which run through the houses should be taken up, the *debris*, if possible, removed, the trenches disinfected, and glazed ware pipes substituted. They should even be taken up to a considerable distance from the house, or, best of all, abolished altogether.

The proper authorities insist upon the undermentioned regulations being *carried out, viz.*, that natural streams should not be coerced int

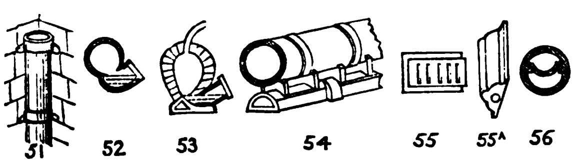
forming sewers, that straight lines and true gradients should everywhere prevail, that they should not join at right angles, that, like the smaller drains, the tributaries should only deliver in the direction of main flow, that the bricks should be moulded to the proper radii, and set in hydraulic mortar or cement, and that flap-traps should be inserted at the drain deliveries to keep the wind out of the drain. In wet subsoil, too, they should be compelled to serve as land drains, see Fig. 54, page 24, where I give the best means, which I know, of effecting this. It is left optional whether the sewer is to be made to accommodate flood water, as that can be carried off in surface channelings without danger. They may also have flood water overflows in case of extra wet weather. It is, however, made indispensable that the inverts of different size sewers should not be laid upon the same level, but that the difference should form a fall for the lesser sewer. They should furthermore be constructed with manholes, and flushing and ventilating arrangements, at the chief changes in gradient, or at the least about 100 feet apart.

PRICES OF EGG-SHAPED SEWERS.

Height of Sewer inside.	Width at Widest part inside.	No. of Bricks per yard run exclusive of Invert.		Cost per yard run, laid complete.	
		In 9 in. work.	In 4½ in. work.	In 9 in. work	In 4½ in. work.
ft. in.	ft. in.			£ s. d.	£ s. d.
4 6	3 0	384	...	1 19 2	...
3 9	2 6	336	156	1 15 9	1 5 9
3 0	2 0	256	116	1 10 8	1 2 7
2 6	1 8	216	100	1 8 0	1 1 3
2 3	1 6	208	92	1 7 3	1 0 5

The foregoing prices are based on the reasonable assumption that the bricks cost 30*s*. per 1000; that the cost of mortar and men's time laying them is 23*s*. 4*d*. per 1000 bricks; and that the excavation could be done at 1*s*. 8d. per cube yard.

PIPES FOR SPECIAL PURPOSES.



51 52 53 54 55 55^A 56

That earthenware pipes are not always used for laying in the ground,

but can be advantageously made use of for rain-water pipes, and chimney flues, can be seen at Fig. 51, which represents a glazed ware pipe erected against a building. These pipes are made by Mr. G. Jennings, either to fix in angles, as shown, or upon straight walls, and have iron collars fitted with ears, so as to secure to the brick or stone work. They are made from four inches to twelve inches diameter, and cost from 1s. 6d. to 3s. 6d. per foot run. The only improvement I could suggest, where used for rain-water pipes, would be the adoption of the invention patented by Mr. Taylor in 1863. This is the substitution, at the bottom-most length of the stack, of a pipe still larger, so that this last pipe can be slipped up and down for a short distance. By thus moving the pipe upwards, the drain-trap into which it is fitted, if it must be fitted into a drain-trap at all, can be effectually cleansed out.

Figs. 52 and 53 exhibit a very sensible arrangement, patented about two years ago by Mr. T. Walker, of 48, Oxford-street, Birmingham, and it has proved itself, after a long trial in the streets there, to to be very efficient, not only in fine or moderate, but also in rainy weather. As will be seen at Fig. 52, which shows a drain-pipe of ordinary glazed earthenware, the inventor arranges the openings for the pipes leading into the main at the bottom of the said main instead of at the breast or at the top. By this means the outlets of the subsidiary drains into the main drains are covered by any sewage water in such mains, and the feeding drains are automatically or self-trapped.

Fig. No. 53 represents the same idea as applied to a brick sewer and gully trap, and as the pipes are placed in the sewer bottom, where there is always some running water even in the most droughty seasons, the water forms a perfect trap, and stops the exit of any effluvia from the main. This constitutes, therefore, a gully pit, without a mechanical trap of any sort whatever. The pipe issuing from the top is a 6 in. diameter pipe, which passes from the sewer roof under the road formation to some convenient spot, where it can be taken up the side of a building, and the gases discharged at an elevation superior to that of the surrounding house windows. These ventilating shafts are not new, but in such a situation as now described they are said to cause such a suction from the sewer that but few are wanted, and the air is speedily rid of the noxious gases. Of course this statement is a com-

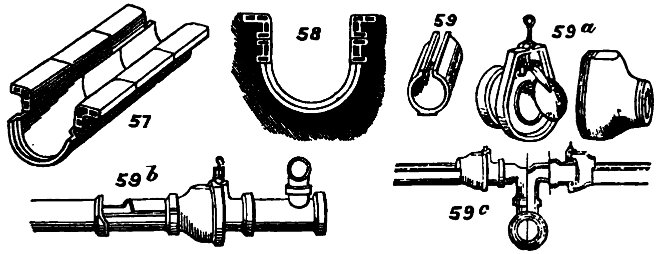
parative one. Such a ventilator would serve well in a system of brick sewers upon a large estate in the country, but it would act feebly in the sewers of populous towns, in comparison with the ventilation which such sewers ought to receive.

Another peculiar arrangement of pipes which might, in some combination of surroundings, become almost indispensable, is seen at Fig. 54. It is a system invented for sewerage in running sand or wet soils, and consists of a drain-pipe of large diameter, supported by a loose pipe-rest upon a subsoil drain below. It was patented, and is manufactured solely by Messrs. Brooke and Sons, of Huddersfield, and several miles of it have been laid down by some Liverpool engineers, with great success.

This system provides a comparatively dry foundation for drainage pipes in swampy and insecure ground, as the subsoil water is carried off in the retort-shaped pipe underneath. The joints of the subsoil pipes are loosely protected by clay or other material, so as to admit very freely the subsoil water, but prevent a large ingress of sand or earth. The chief merit of the invention, of course, consists in enabling a water-tight joint to be made in the upper or sewer pipe, in providing a more solid foundation, and also in due time permanently reducing the water level below the level of the sewer. The water above this level is shut out from the sewer and sewerage, and is made to flow in the subsoil pipe where most wanted, and this comparatively pure water can be at any change of level turned into the upper or sewer pipe through a man-hole, and used in flushing the subsequent lengths of sewer. Or a man-hole can be made in the sewer above, and on removing a cover underneath this in the bottom of the sewer pipe leading to the subsoil pipe, the storm or other waters can be utilized in scouring the subsoil drain itself.

Mr. Long, of Yarmouth, in 1857, invented a drain for distributing sewage over farm lands; and Fig. 55 shows a plan of the underside of a pipe of his, with perforations made in it to admit of the liquid portion escaping into the earth; it also exhibits the socket of these pipes and the two strengthening flanges that run along the outer circumference. Fig. 56 gives a section of his drain-pipe, with a metal or wire shelf in the same so contrived as to separate the solid from the liquid sewage. I have been unable to obtain any information respecting the working of these pipes. I greatly doubt their success.

A very useful American combined bordering and drain tile for forming the borders of flower beds and edging walks is sketched at Fig. 55*a*. It is known as Biehl's patent, and the pattern should be popular on this side the Atlantic.



I will here describe the patent open channels and flanges of Messrs. H. Doulton and Co., of Lambeth, which have been specially contrived for sewerage, irrigation, and for use in sewage farms. The channels or gutters are of earthenware, and these are glazed, as it has been found that not only ditches and rough conduits of bricks, but also unglazed material, harbour vegetable growths and impede the flow of the liquids, not to mention the incessant labour of cleansing them out.

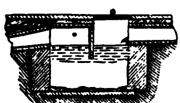
These channels are mostly semi-circular in section, as shown at Figs. 57 and 58, and are either socketed or butt-jointed, as may be required. Situated along the sides are moulded coping pieces, cast hollow to save material, and these are flanged as seen. The flanges can either be fixed the same height on both sides, as drawn at Fig. 57, and the overflow of sewage made to pass over both projecting lips, or one side can be made higher than the other, thus forming a capital footway for the labourers. These carriers or distributors are made from 9 in. up to 30 in. in width, but a concrete backing would be advisable where the larger diameters are adopted. Fig. 58 shows a cheap and effective system of deepening the channel and so increasing its capacity, which is done by the insertion of an intermediate tile laid between the semi-pipe and the coping. At Fig. 59 is engraved another kind of pipe made by the same firm, with a longitudinal slit along the top to allow of the overflow of the sewage-charged matter upon the land.

For stopping, *diverting*, and regulating the distribution of the sewage,

Messrs. Doulton and Co. supply the stoneware sluice valves which I show, (taken apart to exhibit the working) at Fig. 59*a*. A method of using these valves so as to permit the mains to be completely buried out of the way of ploughs, is shown at Figs. 59*b* and 59*c*. By closing the valve shown on the elevation at Fig. 59*b* the sewerage rises through the pipe shown above the main on Fig. 59*c*, and discharges right or left through the two valves there into the distributing carriers. A lidded pipe, like Fig. 17, page 12, is here especially useful, as if one is put next to the sluice, the interior of the valve can be easily reached. This deep main adaptation of Messrs. Doulton's valves is the invention of Messrs. Lawson and Mansergh.

CESSPOOLS AND LIQUID MANURE TANKS.

It will not be necessary to explain what a cesspool is, for, unfortunately, they are still too common. I use the word cesspool in the sense of an underground tank, made to receive all kinds of manure and *effete* matter, not in the sense of a large trap, such as is drawn at



59*b*

Fig. 59*b*, and which represents an Edinburgh street area cesspool, serving only to disconnect in a primitive way the house drain from the system of sewers. The sketch here given is copied from the *Builder*, and exhibits a cesspool trap with an evaporating surface of *seven* feet, emitting, of course, a horrible stench around. In Yorkshire the word is also applied to an effluvium trap of a similar description.

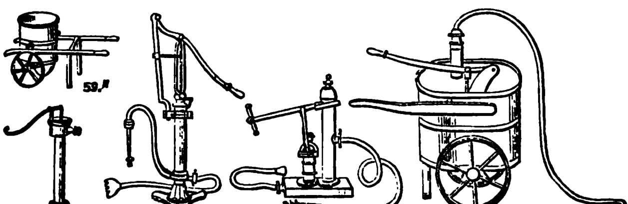
The true cesspool is now being fast abolished in towns, and will soon be permitted only in outlying districts, where there is no drainage system. In some towns, however, even up to the present day, they form the only kind of drainage receptacles, and many of them are not cleaned out for ten or twenty years. I could name a fashionable watering-place in the south of England which might justly be called a town of cesspools. Would it be believed also that within two and a half miles of Regent's-park that there exists a suburb, containing 1500 inhabitants, whose houses drain either into cesspools or into an open ditch. Yet such is the fact, and what is more, I have every reason to believe that much of the foul matter reaches the Regent's Canal, by way of its feeders.

It was calculated, in 1848, that there were over 300,000 of these cesspools in London alone, with an exhaling surface of 2¾ million superficial feet, or nearly 62 acres, and containing over 17½ million cubic feet of foul material. This state of things was also declared to carry off before their time about 26,000 people. To point the moral more conclusively, I have only to instance the late outbreak of fever at Buenos Ayres. In that city, as in most others on the River Plate, sometimes as many as six cesspits are to be found under a single house; and when the last of these are full another one will be dug. The result is, that not only do the inhabitants move about in an invisible fever cloud, but the few *manantiales* or springs which they possess, and the majority of the *algibes*, or covered rain water cisterns, suffer horridly from infiltration. And not only in this wholesale manner are cesspools dangerous, but they may become singly a source of peril if not regularly cleaned out. A periodical cleansing, say once a month, is indispensable to health. If allowed to remain uncleaned for a longer space of time, say even six months, the sulphuretted hydrogen evolved becomes highly pestiferous. Cases of asphyxia moreover often occur in emptying night-soil tanks; for instance, not long ago, at Bradford, one of four men engaged in cleansing one, only 7 ft. deep, succumbed to the fœtid gases. I will, however, not enter into the different systems used in London about twenty years ago, for emptying these receptacles, when, by the cylinder and pump process, twenty-four loads of soil were pumped out at a cost of only 24s., in less than four hours' time. Still this is sufficiently wonderful. The Surveyor to the Metropolitan Commission of Sewers informed the Board that, without such machinery, the removal of the deposits would have occupied three nights, and cost just twenty times the expended sum. In New York the street cesspools are similarly emptied every day, and the cost of the engines used, average, I believe, the sum of £20, when worked by hand labour, as would be the case on even a very large establishment.

In the proper place, under the head of ashpits, I will describe the best kind of sanitary appliances for isolated houses and small hamlets. At present, and still using the word cesspool in its true sense, a ...em receptacle for sewage and waste water, I will explain the best ...*tank* of constructing them on the liquid manure tank principle ...per than *should be arched over* with a manhole in it, and p...

6 or 7 ft., though as long as convenient. If much deeper the hydrostatic pressure will necessitate expensive walling. The walls should be built of brickwork in cement, and should be puddled behind with a foot of well-worked clay, and rendered over inside with best Roman cement. The bottom should also be formed of an inverted arch, and should slope towards the end where the pump is to be fixed. The tank should also be divided at some distance from the other end by a galvanized iron grating, which would prevent the solids from reaching the space devoted to the more liquid manure. If too small to cover over with an arch a flagstone can be fitted over the whole, but in any case a moveable stone should be laid over the manhole, to enable the grating to be cleaned and the solids from time to time removed. An upright pipe for ventilating purposes should, moreover, be fixed to the tank, resting, for instance, upon the top of the divisional wall and above the overflow. Such a tank, 10 ft. long 6 ft. wide and 6 ft. deep, ought not to cost more than £10.

Provided with a tank such as I have just described, in the best situation for the gardener's use, means should be provided for the purpose of utilizing its contents. The lifting from the well can be effected by a pump fixed over the well, of the kind which is used for filling buckets, that is, without any delivery hose; or a pump can be fixed in the centre of the garden, or wheeled about, with such a hose attached, and with a suction tube of proper length. A still more powerful apparatus can be made, serviceable for either of the above purposes. In the distribution of the manure, sometimes a tank barrow is used, and the liquid dispersed by a watering can, or a tank barrow is fitted up with a pump and made to deliver the contents through a hose like a fire engine. The last-mentioned system is the best, and in the end the cheapest.



59.D 59.E 59.F 59.G 59.H

A galvanized iron liquid manure pump for general use is shown at Fig. 59*e*, and this is the simplest method of pumping into a barrow, or into wooden or other distributing troughs, in order to swill the roots of the plants. A more elaborate article, fitted with a hand branch, a rose, a single jet, a suction hose, and a strainer as well, and known as Orford's patent standard force pump, is exhibited at Fig. 59*b*. This will draw water horizontally, say from a pond with the hose lying upon the ground, a distance of 150 feet, or if fixed over a well or tank it would raise the contents 20 feet perpendicularly, throwing in each case a continuous stream. A somewhat smaller pump is made, moreover, on the same principle, but with a pull-up handle. A strong hand-pump, for the same purpose, is drawn at Fig. 59*g*, consisting of a gun-metal barrel and a copper cylinder air vessel, fixed up a galvanized iron platform, to which the suction hose is attached. Two delivery hoses are screwed to two outlets at the centre, and one to the top of the air vessel if necessary. If wanted to be fixed beside the well, it is bolted through holes in the platform to planks, but, although the air vessel and long lever handle give it a heavy appearance in the sketch, it can be easily carried about and worked by a man. Such a pump will discharge, in an uninterrupted stream, to a distance of 40 feet.

A barrow on wheels, to hold 25 gallons of water or liquid manure, constructed of sheet iron, with angle iron frame, is given at Fig. 59*h*, but at Fig. 59*i* is drawn an improved engine with brass pump, air vessel and lever handle, which would be far more serviceable. This latter would eject a compact column of fluid some 40 or 50 feet distant, and yet be worked by one man, pumping with one hand and discharging with the other. In these pumps and distributors the round jet can be superseded by a fan upon the hose, which will emit the liquid in the shape of fine spray. I consider that this is, however, only useful for watering. As a rule, the liquid sewage should be distributed at the roots of the plants, which is sewage irrigation in fact, on a small scale. Some of the above engines would be valuable even in case of fire. Of course a double barrel or double action pump would be more effective than any of the above, but they would be on too large a scale for private establishments. The following are the prices of the above, taken from a London circular, that of Messrs. Sheath Bros., City-road.

Fig. 59*e*, without head, 25s. & 30s.; with head, 30s. to 40s.; suction tail pipe, 1s. & 1s. 3d. per foot extra.

Fig. 59*f*, with 3 ft. of delivery hose and 3 ft. suction hose, and strainer, 70s.; Ladies' size, 58s. 6d.

Fig. 59*g*, as shown, 190s.; on a barrow, 220s.; suction hose, galvanized, 3s. 6d. delivery hose, 1s. 6d. per foot run extra.

Fig. 59*h*. to hold 25 gallons, 45s.

Fig. 59*i*, to hold 12 gallons, 63s.; 16 galls., 78s.; 24s. galls., 105s.

There is one thing greatly conducive to the healthy state of the outbuildings, and that is whitewash. It is to be regretted, however that in most places the people are "getting above it," or only practice it when driven to it by the authorities in their enforcements of the Sanitary Act of 1866. Common whitewashing can be practised with great advantage on walls in the neighbourhood of the sewage tank.

Disinfecting whitewash has hitherto been made up by adding to every bucket of limewash half-a-pint of undiluted carbolic acid; but it can be made in many other ways. The ordinary whitewash is well known, but I give here a method of making it, copied from an American paper, which is well worth attention. In America they use the whitewash brush quite as much as in Wales.

"Take a clean water-tight barrel, or other suitable cask, and put into it half a bushel of lime. Slake it by pouring water over it, boiling hot, and in sufficient quantity to cover it 5 in. deep, and stir it briskly till thoroughly slaked. When the slaking has been thoroughly effected, dissolve it in water, and add 2 lbs. of sulphate of zinc and 1 lb. of common salt: these will cause the wash to harden, and prevent its cracking, which gives an unseemly appearance to the work. If desirable, a beautiful cream colour may be commuicated to the above wash, by adding 3 lbs. of yellow ochre; or a good pearl or lead colour, by the addition of lamp, vine, or ivory black. For fawn colour, add 4 lbs. of umber—Turkish or American, the latter is the cheapest—1 lb. of Indian red, and 1 lb. of common lamp black. For common stone colour, add 4 lbs. of raw umber, and 2 lbs. of lamp black. This wash may be applied with a common whitewash brush."

CHAPTER IV.

ORDINARY HOUSE-TRAPS, WASH-TROUGHS, AND BASINS.

TRAPPING is the interposing of water between the atmosphere which we breathe and that which is contained in drains and sewers; and it has engaged the attention of sanitary engineers since, at all events, the year 1840. Traps—useful in an auxiliary sense only, and on no account to be solely depended upon—have undergone nearly every possible modification; but as all traps ought to have a shield of water to ward off effluvia, it follows that they must mainly differ from each other in shape, size, and material.

Generally speaking, a trap should be constructed of metal or pottery, as the cost of cutting bricks, and of hewing stone, and dishing out the surface is comparatively great. The chief reason for this, however, is because bricks or stone collect filth and absorb grease, whilst the glazed or enamelled terra cotta, or the smooth-surfaced cast or wrought irons are free from these drawbacks, and are also readier cleaned. I should like to see all iron traps subjected to the Lavenant patent preserving process, which I shall describe under the head of water appliances. A trap should also be contrived so as to exclude vermin, but this is more applicable to the larger articles. Rats are proverbially given to exploration, and have been known to dive in at one end of a syphon pipe-trap and out at the other, in their predatory excursions.

There are traps and traps, just as I may say that there are watches and watches. Despite the differences in the escapements, these time-pieces all give more or less correct time for a season, and in a similar manner all the various traps really act as traps for a certain period. But as the best watch is that which is constructed on the soundest principles, of the best materials, and which needs the fewest repairs, so the best water trap is that which for the longest space ensures an unbroken water seal at the junction to the drain. I could even say

that as watches, constructed for special purposes, are to be judged by the manner in which they fulfil all the particular requisitions, so a trap is not to be condemned because, whilst meeting the requirements of one case, it proves a defaulter in another. To complete the simile, ventilated traps, which I will describe anon, are to closely sealed traps what highly finished chronometers are to the finest lever watches, absolutely necessary under special conditions.

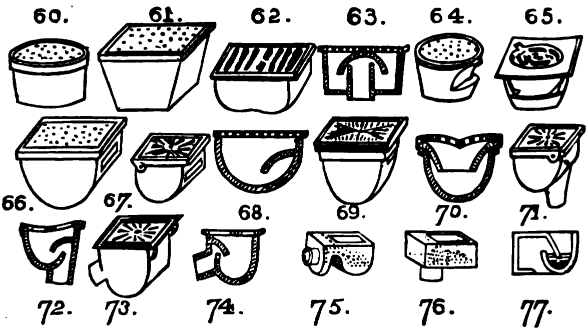
It will, however, hardly be credited that the syphon trap, figured at Fig. 39, page 14, now the commonest article of use, was not invented previous to the year 1844, and that, even in 1846, it was joined below the water-line, and consequently open to very grave objections, whilst proving a real boon. Whatever may be penny-a-lined about the civilization of the ancients, I do not think that traps were ever dreamt of by them, for we have dug up quantities of pipes on the sites of ancient cities, and found no trace of such an article. Indeed, the invention was considered twenty-four years ago so novel that it was not unusual to hear different people disputing the origination of this simple contrivance; and, in 1848, I notably recollect three or four wordy claimants to a self-acting trap which is now altogether shelved. Let us, nevertheless, honour these men. Let us consider the immense stride which they made out of the cloacine darkness; and if we cannot in our thankfulness exactly separate our wrestling benefactors, let us pour them out a pure libation, even if they come before our mind's eye all bundled up into one like a Hindoo god.

A house trap, as I stated before, is not to be relied on solely. Neither the kitchen sink, the scullery washing-trough, the lavatory basin, the bath overflow, or the cistern waste should be without a trap; but the trap should just have sufficient to perform, which is mainly to keep out the cold air in winter, or the slight effluvium which might rise up from the open grating over which the waste pipe of the above places empties itself.

SINK TRAPS.

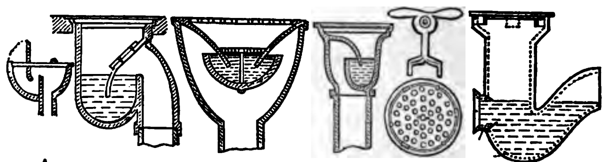
At Fig. 60 I sketch a round sink trap; at Fig. 61, a square sink trap; at Fig. 62, an oblong sink trap, and a general section of these commoner traps is figured at Fig. 63.

Modifications of the ordinary sink-traps are exhibited at Figs. 64



and 65, and their working is obvious without drawing a section. What are usually called D sink traps are also very handy articles. Fig. 66 is a D trap without a hinge, and Fig. 67 a hinged trap of this description, whilst a section of both is shown at Fig. 68. An improved D trap, as will be seen by the section, Fig. 70, is shown in elevation at Fig. 69. Of those sink traps, however, the traps of which are formed at one side only, I figure two—viz., Fig. 71, with its section, Fig. 72; and Fig. 73, with its section, Fig. 74,—the latter being shown with a hinged lid. The foregoing are all made in cast-iron. I append the prices, delivered at the railway station by the manufacturers, Messrs. Butt and Co., ironfounders, of Gloucester. Amongst small earthenware traps for house use, notice ought to be directed to the horizontal house-trap, Fig. 75; to the down-outlet house-trap, Fig. 76, and also to Fig. 77, or what is called the Manchester house-trap. They are made and sold by Messrs. Brooke and Son, and as simple traps are simply perfect.

	3	4	5	6	7	8	9	10	12	Inches.
	s. d.	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	
Fig. 60	0 7	0 8	0 10	1 2	1 6	1 9	2 2	2 6	3 0	Each.
Figs. 61 and 66...	...	0 11	1 2	1 5	1 7	2 0	2 4	2 6	6 0	,,
Fig. 64	...	...	1 0	1 2	1 6	1 10	...	...	...	,,
Fig. 65	...	...	...	2 0	2 6	3 4	4 2	5 4	6 10	,,
Fig. 75	...	2 6	...	3 6	...	...	...	...	...	,,
Fig. 76	...	3 0	...	4 0	...	...	...	...	...	,,
Fig. 77	...	...	...	2 0	...	...	3 0	...	...	,,
Fig. 62	6, 7, and 8 inch, 18*s.* per cwt.									
Figs. 67,69,71,& 73	6 to 11 inch, 22*s.* per cwt.									



77A. 78. 79. 80. 81. 82.

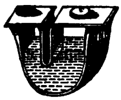
The moment we leave the above stereotyped traps we pass directly into the grassy meadows of Invention, and, as we shall shortly observe, the crop is not a sparse one. If the reader looks again at Fig. 72 he will observe that there is no means of access into the waste pipe after once passing up the division of the trap. To remedy this, which in a large trap would be an evil, Mr. Lowe some time ago invented a trap which is shown at Fig. 77*a*. A small perforated lid is here made to rise up, by which means the refuse can be collected in the trap-bottom, and a small orifice is also left over the main descent, through which a cane can be passed to clear out any obstruction in the waste pipe itself. Mr. Simmonds also, a London plumber, contrived the enamelled iron sink shown at Fig. 78. Instead of having the diaphragm or midfeather which projects from the top to the middle of basin curved, as shown at Fig. 72, he makes part of it vertical where it rests in the water, and above that he forms an opening, which he closes by a plate, screwed on when the trap is in use, and easily removable when it is wanted to push a cane down the outlet pipe to clear it from obstructions. A good feature in this trap is the forming of the overflow channel exterior to the body of trap, by which means a good scouring can be secured. A sink trap, of a different construction, is sketched in section at Fig. 79, the patent of Mr. Gummer, of Rotherham, in Yorkshire. In this instance the pipe-head is enlarged to a cup, and fitted at top with a loose grating. There is also a trumpet-shaped tube made having a grating cast to it, from the centre of which grate an inverted bell is suspended by an iron rod. The trap is thus complete, and the solid matter stops at the bottom of the cup, there not being sufficient room for it to pass the water joint. When the whole is screwed down to the sink, it is not easily tampered with by servants. It can, however, be quickly cleaned out when wanted, as upon unscrewing it the perforated plate or *grating at top* comes away, and brings with it the whole of the *trap.*

The best trap which I have yet met with to prevent the pranks which are continully played with the gratings, and to compel the housemaid to collect in the proper basket the multitudinous scraps of food that would benefit alike the pig or the fowl, is that known as Antill's, a plasterer, who invented it in 1868. It is made and sold at Mr. Finch's Sanitary Works, 181, High Holborn, London, and I give a sketch of it at Fig. 80. It is made of pure pig-lead, but the larger sizes can be got cheaper in iron. The lock grate to fit upon the top of this trap was invented by Mr. Stidder, the Manager, and is shown at Fig. 81. The peculiar key or spanner fits into two holes of the perforated plate, and a thrust of the hand locks or unlocks it. No screws are needed, and the device is very ingenious. In the larger iron traps of this description a kind of railway carriage lock is fixed near one part of the rim, and is more effective for the heavier lids. These lock grates are separately sold of all diameters, with their proper locking rims, so that they can be soldered down over any existing traps whatsoever.

The very best constructed sink traps will foul with grease in time; but if the mistress, or housekeeper, would keep the keys and see them duly cleaned out at regular intervals, the above traps, and trap gratings, would prove a boon. A similar trap was introduced to notice by Messrs. Tye and Andrews, of London, about ten years ago. Its arrangement is shown at Fig. 82. The main feature is the abolition of the trap at the top of the waste pipe, and the substitution of a syphon trap low down in the pipe. Should the drain require frequent flushing, by lengthening the distance between the trap and the grating, advantage is gained of a good column of water to force a passage to the drain.

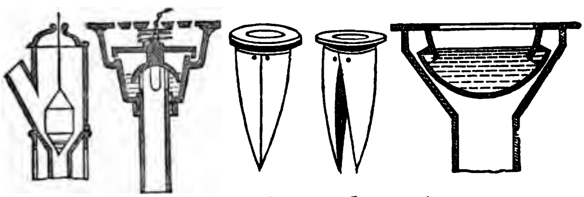
I need only append the prices of the two last-mentioned traps.

	2 in.	2½ in.	3 in.	3½ in.	4 in.	4½ in.	5 in.	6 in.	8 in.	10 in.	12 in.
	s. d.	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*
Fig. 80, with grate and key, Fig. 81 in lead	1 6	1 10½	2 3	2 7½	3 0	...	...	...	...	...	...
Ditto ditto in iron	...	...	1 0	1 3	1 7	...	2 2	3 3	4 9	6 6	8 6
Fig. 81, grate & key separate	1 1	1 2	1 5	1 8	1 11	2 4	2 8	3 4	...	...	...
Fig. 82			5 6 to 8 0		6 6 to 11 0			25 0 to 35 0			



82.A

An improved lead trap for sinks, &c., the invention of Mr. Laing, is sketched at Fig. 82*a*. On the top surface of the outlet shoulder of the trap a brass manhole is fixed so as to enable the trap to be cleaned out. He considered that the doubled lead division makes a better dipping surface than the usual sharp edged ones; but I look upon the open cleft which is thus formed ready to receive any nuisance as a decided fault.



83 84 85 86 87

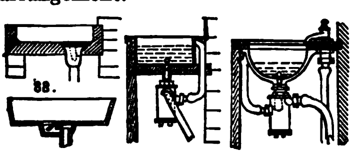
I cannot forbear noticing here a peculiar sink trap patented by Mr. Buxton, a contractor, of Hunslet, in Yorkshire, about 1866, and therefore draw it at Fig. 83. He constructs an earthenware teapot-shaped vessel, the spout of which forms a communication with the pipe of the sink, and at the bottom, where it joins the ejection pipe, it is tapered out to receive a conical plug attached to a float. Upon the entrance of water into this receiver, the float rises as a matter of course, and the waste water is carried away. The suspension string keeps the cone, float, and plug in position, so as to fit exactly upon the packing round the outlet. One peculiarity of this trap consists in its efficiently carrying off solids as well as liquids.

An elaborate invention for a sink trap is drawn at Fig. 84, the production of a gentleman named Wilson, who patented it in 1870. When closed down, the spring presses forcibly upon the indiarubber band fitting in the groove around the trap, and so shuts off the smell. The traps are threefold—the bell-trap at the bottom, the tight-fitting flange upon the indiarubber, and also any water that may lodge on the top of the indiarubber flange. When the sink is in use the chain is pulled up, and a pin passed through a link of the chain on the top of grating. This trap is manufactured by the Carron Company, *Upper Thames Street,* London.

Our American cousins have a very peculiar sink trap, known as Faber's Trap, shown at Figs. 85 and 86. It is composed of a ferrule or ring, with a broad flange at the top made to rest on the bottom of the sink, and at the top of the waste pipe. To the barrel of this flange two half-funnels are pivoted by four small rivets. These shells project down into the waste pipe, and when empty close by their own weight, forming a longitudinal joint in the whole length, which is both gas and water tight. Waste water flowing from the sink parts these asunder, as shown at Fig. 86, and they subsequently close together, as shown at Fig. 85. Another Transatlantic sink trap is exhibited at Fig. 87, which is a decided improvement upon many of the iron sink traps used by the million in this country, and was invented by Mr. Shaw in 1864. It acts both as a sink strainer and stench trap. The outlet pipe is made with an enlarged mouth, and there is fitted within that a circular flange, with a curved ring projecting a short distance downwards. Underneath this is a hemispherical cup, the edges of which extend a little above the edges of the last-mentioned ring, leaving a space between the two, where water, but not solids, can freely pass. It is covered with an ordinary grating.

WASH TROUGHS AND BASINS.

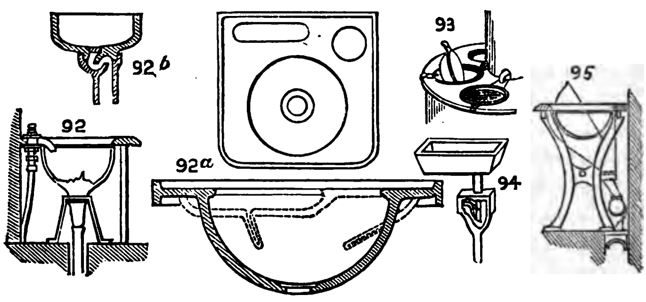
These contrivances naturally follow the subject of sink traps, but I will only mention a few late improvements upon them and then notice the traps which are useful in the yards and roads. It must be understood that in all cases I advocate the delivery of the waste pipe into a drain disconnected from the sewer, or a delivery at a foot above an open yard grating. On no account should the overflow pipe of a sink or basin connect with the main drain. Perhaps half "the ills which flesh is heir to" might be traceable to some such a pernicious arrangement.



88. 89 90. 91.

Although not long introduced the ordinary troughs and basins with plugs at the bottom and with supply taps, and the still newer ones with stop valve supplies, are sufficiently familiar as not to need any description. I have to call attention, however, to

several improvements which merit every recommendation, and will be found invaluable about a house. One of these is the scullery sink, with the Antill trap. This sink complete is shown at Fig. 88. and is made of pottery ware, fitting in the simplest way upon the half brick wall running underneath. It also rests on a chase in the wall. They are made to suit 3, 3½, and 4 inch waste pipes. If the reader will compare this sink with that drawn at Fig. 89, he will see the difference between a good trap and an indifferent one. This trough, Fig. 89, is an American one, Carson's, and it has been in use there for about ten years. It is merely a small dip trap formed in a chamber under the trough, the eduction pipe passing into it sufficiently high to seal the trap with water. A wash trough having an intercepting chamber is drawn at Fig. 90. The discharge plug passes the waste water into the trap beneath, and any article which may have sunk through the valve at the bottom can be recovered by turning the thumb-screw below the trap. No sediment of any kind can pass into the drain. A stench trap is also formed in the chamber shown by the dotted lines at Fig. 91, which figure shows a basin of a similar description, but fitted up with a patent anti-vibration stop-valve adapted for hot or cold water. The article-intercepting trap is the same in both.



A very cleanly washstand slab, which drains the soap and brush trays, known as the Atlantic wash slab, is drawn in plan and section at Fig. 92*a*, and this costs, with patent plug and chain, a guinea. It is manufactured by Copeland and Sons, of Stoke upon Trent. At Fig. 92*b* is exhibited a washing sink with trap below, constructed entirely of glazed earthenware, and therefore rather a novelty. It is

made by Mr. Grieve, of Prestonpans, and would be a desirable article if it were not so liable to breakage. Another very useful and simple slop basin, costing 28s. 6d. complete, is shown at Fig. 92, where both the basin and lock-grate stench trap rest upon a stand screwed to the floor. By pressing the stop valve at top all impurities are removed by the flush of water which follows. Several of these carefully designed contrivances will be found quite a necessity about any cleanly conducted establishment. The traps, Figs. 90 and 91, are manufactured at the High Holborn Sanitary Works, London, and the prices of the fittings, not including the troughs, or basins, which may be of any ordinary sort, are as under:—

		DIAMETER OF PLUG.		
		¾ in.	1 in.	1½ in.
		s. d.	*s. d.*	*s. d.*
Fig. 90	Soap Traps without overflow.............	9 6	10 0	14 0
	Do. with do.	11 0	11 6	15 6
and	Plug and Washer for Basin	2 0	2 6	5 6
Fig. 91.	Do. do. with Chain and Union for Basins.....	3 4	4 6	...

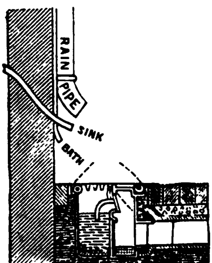
Press down valves, 10*s*. 6*d*. each. If for high pressure, 2*s*. 6*d*. extra.

		s. d.
Fig. 88 sink, with trap complete.	Size 24 in. × 18 in.	8 9 each.
	" 36 in. × 24 in.	15 1½ "
	" 48 in. × 24 in.	20 6 "

There is a favourite basin—one that has seen good service over the whole world, and known as a tip-up basin. It will be found useful where it might be feared that any deposit left on the plug-hole drained basins would be a means of communicating disease. One kind of these basins is drawn at Fig. 93, and is made and sold by Mr. G. Jennings, of Lambeth. The prices vary with the quantity of ornament and the number of basins, though they are also sold singly, and fitted up on suitably cheap pillars. In this kind of tip-up basin the used contents are thrown direct from the basin by tipping up the projecting lip, and the lowering of it to its former position ensures a fresh supply of water. A still better basin, in my opinion, is drawn at Fig. 95. It has just been

introduced by Mr. Finch, and is called the Pivot Supply Lift-up Basin. The hot and cold water both enter the basin through the pivots, and by this means a more effectual flush is given to the basin whilst inverted. The supply valves and other obstructions on the top of the slab are here also dispensed with. An American wash-trough trap (Hatfield's) is shown at Fig. 94, and we figure it for its peculiarity. The lower end of the depending waste pipe is cut to an acute angle, and a flap is hung to this so as to fit closely to the edges of the pipe. Just above the hinge of the flap a weighted lever is balanced, which keeps the valve closed when no fluid is passing down. The valve is enclosed in a box, drawn partly broken in our sketch to show the lever. The worst of this kind of trap is, that it is not water-sealed.

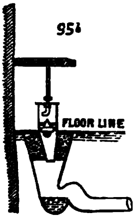
In no case should the waste pipe of sink, lavatory, or bath, or any of the safes thereof, lead direct into the drains. Yet, how frequently is this the case, and a special card of invitation sent out to Disease and Death. It must also be remembered that it is every whit as dangerous if these waste conduits lead into the soil pipe of a closet, or into a rain-water pipe, which is in direct contact with the drains.



95A

Waste pipes from the above-named places. and also all rain-water pipes should be led down to within 12 or 18 inches from the ground, and should deliver on to the grating of a gulley or yard trap, such as sketched at Figs. 99 or 102, p. 42. If needful, a larger yard trap can be used, such as shown at Fig. 95*a*., which is an adaptation of Fig. 109 p. 45; or if this is too small, an effluvium trap can be constructed of bricks and mortar, as shown at Fig. 126*a* p. 55, but with the pipes delivering themselves over instead of under the grating of the trap.

This cutting of the connection of the waste pipes with the drain does not, however, as I before stated, dispense with the necessity of a trap in the sink, wash basin, or bath bottom, or of a syphon trap in the pipe itself. Trapping will still be necessary to keep the cold air from the inside of house. If the gulley trap, over which the waste pipes discharge, smells offensively, it may be necessary to fix within it a tray of some deodorizing material, such as is recommended further on.



An attempt to obviate the necessity of disconnection of the sink with the drain is exhibited at Fig. 95*b*, and is the invention of Dr. Taylor, of Anerley. A shallow sink is here furnished with an ordinary bell trap at the upper end of the waste pipe, and the other end of the waste pipe is turned up to act as a syphon. This last portion is enclosed in a valve box, which contains a float or valve somewhat resembling that at Fig. 83, p. 36. The continuation of this valve box downwards is through a surrounding annular box of charcoal, and thus is constituted in a certain sense a filtering chamber for return gases. Below this is the usual syphon trap. The chief feature here is the application of charcoal to counteract the return gases from the drains into the house. I illustrate this system in case an instance might occur in which disconnection such as I have before recommended is impossible to carry out.

CHAPTER V.

YARD, GULLY, AND ROAD TRAPS.

YARD GULLY TRAPS.

These, as will be seen, are in a manner distinct from what are called Street Gully Traps, and are used in scullery floors, courtyards, areas, in stables, cowhouses, and so on.

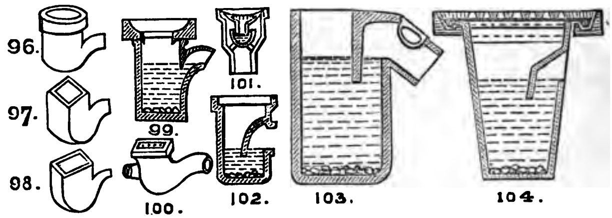
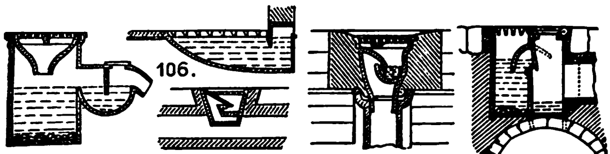


Fig. 96 is called a round gully, Fig. 97 a square gully, and Fig. 98 a rectangular gully trap. These three patterns are usually of earthenware, and are fitted with earthenware perforated covers. They are made at all the clay works, and the prices we give below are those of Messrs. Brooke and Son. Where much silt or sediment of any kind, is prevalent, these gullies are generally made as shown at Fig. 99, with a dished cover, and an iron grating laid above it. A useful departure from the stereotyped plans is drawn at Fig. 100, and is known as Northen's Improved Trap, made and sold at Lambeth. Figs. 101 and 102 are differently constructed gullies; the first-named is not calculated to do much work, however, and is fittest for areas, whilst the latter would serve very well to drain a moderate-sized backyard.

A civil engineer of Kingston-upon-Hull, Mr. Sharpe, has lately patented the gully figured at Fig. 103, and claims the application of glazed stoneware or other impermeable material to this rather peculiar and solid arrangement of gully trap and moveable cover. A Wel-

lington builder, Mr. Shaw, introduced, about ten years ago, the trap shown at Fig. 104, and the novelty lay in the formation of the joint where the trap rests in the frame. When fitted in a laundry floor, for instance, water would nearly always rest in the groove, and so form an hydraulic joint, but evaporation would follow exposure to the sun, and in that case the inventor preferred the groove to be filled with sand. I cannot approve of this arrangement, and give it as a foil to show up its betters.



105. 107. 108. 109.

Mr. Newton, of Preston, four years ago, patented an improved gully or stench trap, which, where a little expense can be gone to, is a decidedly recommendable arrangement. Its general features are exhibited at Fig. 105. Attached to the cast-iron grating is a cast hopper, which, by its shape, reduces the evaporation caused by sultry weather to a minimum, and in winter, doubtless, tends to prevent the freezing of the contents in the receptacles below. The hopper rests in the socket of the sediment box, and on the side of the box there is a syphon arm attached, forming a complete trap, through which the waste water flows into the drain. This box would be operative whether the box below was full or empty. An inspection cap is fitted so as to give access to the dip trap. An American contrivance for these general purposes (Williams's Stench Trap) is shown at Fig. 107. A new feature is the close proximity of the flat part of the middle box to the inclined apron piece. This arrangement would intercept all substances likely to obstruct the drain pipe.

It would be quite in place to mention here the trap Fig. 106, which was introduced by the inventor of Fig. 104. This is a fixed trap, specially contrived so as to be set in the mouth of a drain in a vault or other place where the drain is on a level with the floor in which the trap is built. To clean the trap the grating has simply to be taken up, and the silt removed; the dish should then be filled with clean water, and the grate relaid in the rebate of the trap frame. A remarkably

good trap for laundry, or scullery, or dairy use to be inserted in the floor is shown at Fig. 108, made by Mr. Finch. It is an Antill's trap, made of iron, and set in a block of pottery 4¾ in. thick, and either a brick or a half-brick in length, so as to course with brickwork-on-edge paving. By building it into a glazed pipe, as shown, all rats and other vermin are effectually excluded from an entrance by the drain. Fig. 109, made and supplied by the same firm, represents a stable, cow-house, or stableyard trap. The well under the grating receives any gravel or refuse washed through the grating, and the second well under the hinged cover stops any finer sediment which may have got through the trap from getting into the drain pipe. If so required, the refuse water can pass down direct into the sewer from the second chamber by the dotted lines, and the glazed drain pipe at the side in that case is dispensed with. I can strongly recommend these two last-mentioned traps.

EARTHENWARE YARD GULLY TRAPS.

	No. of Inches in Diameter.										
	2	3	4	5	6	8	9	10	12	15	18
	s. d.	*s. d.*	*s. d.*	*s. d*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*
Figs. 96, 97, 98 Nett price each	1 0	1 6	2 0	2 6	3 0	4 0	4 6	6 0	7 6	10 6	14 0

Fig. 99......9 inch diameter and 4 inch outlet, with dish cover and iron grating complete 8*s*. 6*d*. each.

Fig. 101......8 inch square at top, and 4 inch outlet, 3*s*. 6*d*. each.

Fig. 102......8½ inch square inside, and 4 inch outlet, with iron grating, 5*s*. 6*d*. each.

IRON YARD, &C. TRAPS.

Fig. 108......set in pottery; block complete, 9¾ inches square, 5*s*. each; 13½ inches square, 7*s*. each.

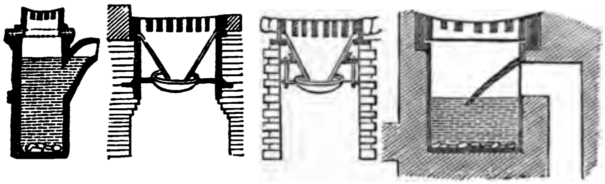
Fig. 109......to suit drains, 6 inches in diameter, 20*s*. each; made also in large sizes.

ROAD GULLIES.

It may appear arbitrary in me to draw a strong line of demarcation between these and the last-mentioned traps, but I do so chiefly in the interest of the reader, who might otherwise be perplexed by the multiplicity and complexity of these articles. For a similar reason I will

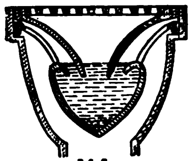
also re-divide the Road Gully Traps into—1st, common trapped gullies; 2nd, sludge box trapped gullies; and 3rd, peculiar trapped gullies, including lever balance traps, ball valve traps, and the like. I will also point out their chief merits and defects. It is to be borne in mind that, although they are concreted under the term road gullies, they are no less applicable to the garden or the farm.

COMMON TRAPPED ROAD GULLIES.

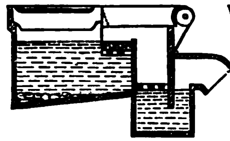


110 111 112 113

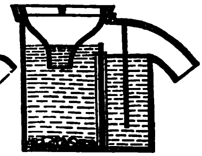
Earthenware gullies of this description have been invented to replace those formerly made of brick-work, the joints of which were always subject to leakage. The smaller sizes are covered with stoneware gratings, and the larger ones, (such as figured at Fig. 110, representing a gully of eighteen inches bore, and four feet in depth,) are supplied with an iron grating to rest upon the brick or stone curb, shown dotted in our section, and which represents the space taken up by the flagging or paving. This gully is made by Messrs. Doulton and Co. At Fig. 111 is shown another Lambeth patent gully by Mr. George Jennings, the case being made of iron, and a proportionably strong iron grating made to drop into the frame. It is sufficiently explained by the sketch. These gully traps are made also in a skeleton form, that is, without the outside casing, and with merely cross bolts to build in the brickwork, so as to hold the trap essentials in position (see Fig. 112). The difference of cost is so slight that the preference should always be given to the former, Fig. 111. The inventor of Figs. 104 and 106 presents also a gully of a different description, which could be made to act tolerably well under certain conditions. This is sketched at No. 113.



114.



115.



116.

I figure at Fig. 114 a trap designed by the inventor of Figs. 79 and 119, and it exhibits a fast plate and trumpet-mouthed hopper dropping into an arm-suspended cordiform receiver. In cases where loose sticks and fodder, &c., are very liable to be washed into the drain a gully such as the one shown at Fig. 115, is well-nigh indispensable. It is certainly the best of its class, and was patented by Mr. Beech, a land agent, of Salford, in 1868. The cover of this trap is formed in one piece with the grating, and is hinged at one end over the back of the overflow behind the water traps. It will be, moreover, noticed that there are two partitions, and also two grids, to arrest floatages. By sloping the bottom of the trap backwards the silt is made to settle in that direction, and a considerable disturbance of the mud layers is thus avoided. With the exception of the intercepting grids and the hinged grating, a similar gully to the last was patented during the same year by Mr. Halbard, of Burton-on-Trent (see Fig. 116). There is this peculiarity about it, that three water traps are in a manner grouped here together at two different levels. The higher partition, which forms the inner side of the mud box, is made to slide between iron guides, so as to take out when the funnel, or hopper, is removed, and when the trap needs cleansing out.

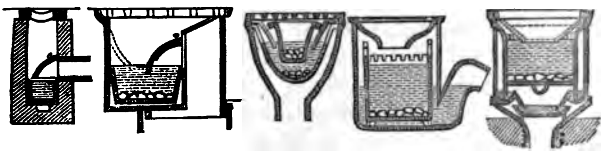
	6 × 6 in.	8 × 8 in.	9 × 9 in.	10½ × 10½ in.	11 × 11 in.	13½ × 13½ in.	15½ × 13½ in.	16½ × 14½ in.	17 × 14½ in.	20 × 20 in.	26 × 18 in.
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d	s. d.
Fig. 111, each	5 0	7 0	9 0	12 0	..	21 6	30 0	...	42 0	84 0	...
Fig. 112, each	...	...	...	...	10 6	...	...	35 0	...	66 0	70 0

For prices of Figs. 115 and 116 apply to the inventors.

SLUDGE BOX TRAPPED ROAD GULLIES.

If the merits of the common trapped road gullies rise to a neap tide level, those of the best sludge box trapped road gullies climb to a

spring-tide high-water mark. For these contrivances ought to include all the good points of the former with the additional advantage of a more or less easily cleaned out gravel or sludge box. They are, however, mostly used in roads where there is a heavy traffic and an incessant scour into the drains; in stable or farm-yards where the incline of the gravel, or pitching of the road, is greater than usual, and at the foot of hills where rock attritions and road washings would soon deprive the trap of its water room.



117. 118. 119. 120. 121.

Figs. 117 and 118 represent two sludge boxed traps, invented about thirteen years ago by Mr. E. Jones. Fig. 117 is a small one built in brickwork, with the drift box in the bottom of the well, and a curved dip plate forming a trap in conjunction with it. The idea is better carried out at Fig. 118. I cannot say that, as they stand, they anywhere approach near perfection; but the inventor may claim a palm of honour in that he was the first to show a recognition of the necessity of ventilating the drains. He has provided for this by the means he has given of unscrewing the bent dip plate which is hinged below the water-line, and throwing it back against the opposite wall of trap, as indicated by the dotted lines. Under the head of ventilated traps I will discuss the necessity of ventilation in such places, but I am now dealing with separately useful articles.

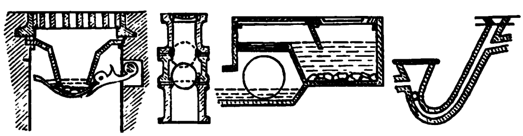
Trap, Fig. 119, was the invention of the gentleman who brought Figs. 79 and 114 into notice. The best features in it are that, on removing the grating, the loose box can be lifted out by a handle which fits the sludge box, and that it can be emptied or replaced by an empty one, without untrapping the pipe.

Mr. Harrison, an ironfounder of Liverpool, has just patented the sludge box gully trap drawn at Fig. 120. The box is fitted with feet, and has a recessed top to receive a perforated cover, acting as a bar between straw, hay, &c., and the drain. It appears in every way

satisfactory, even judged by a high-pressure sanitary standard. Another ironfounder, Mr. Clarke, of Carlisle, invented, in 1864, a thrice-trapped gully which is worth noticing, and which I draw at Fig. 121. The sludge box has a series of vertical gratings at the top, so that little else than water can pass into the drain. Here, too, the drain is trapped, whether the sludge box be absent or present. A handle under the box, and two at the sides, facilitate removal, and the hopper of this gully also is cast along with the top grating.

Let me just note here that the best traps yet in use are the inventions of ironfounders or plumbers, or of professional men and artizans connected with building construction. Antill's trap is a notable instance of this kind. Amateurs, as a rule, have miserably failed. The worst idea broached in connection with traps was by a dentist, who recommended a tight joint of vulcanised indiarubber made by a hinged and weighted flap fitting down into a prepared groove. There was no water trap, no ventilation. The greatest improvement in lead syphon traps, for closet soil pipes, was brought out by a New York artizan, named Lowe, who invented a means of casting a trap whole, and pointed out the construction of a wooden core which could be easily withdrawn. Previous to this, lead traps had been soldered together out of two bent half pipes, and the consequent stretching at the bend rendered them easy of breakage, being too thin where they should be strongest.

PECULIAR TRAPPED GULLIES.



122. 123. 124. 125.

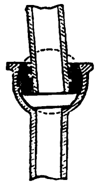
There is a peculiar system of self-acting trap, which I draw at Fig. 122; but it has not been used of late years, owing to the introduction of better kinds. It is said to have acted in places where the gully well was not deep, and where the scoop, when falling, would immerse itself in water. Supposing the mud scoop to be choked, in that case the water would fill up the body of the trap; but when two-*thirds full of water,* the weight of the mud and superincumbent fluid

would weigh down the scoop, which would thus be scoured clean of its contents. When the scoop rose up, it brought water with it to re-form the water-joint. The authorship of this trap is claimed by four or five persons. A similar system of trap, &c., only on a grander scale, and differing in details, is now in use in America, and is known as Voorhees' Balanced-plate Stench Trap. If I recollect rightly, the counter-balance needs a weight of 150 lbs., but when that amount of street washings is intercepted the effect is wonderfully complete.

Another genus of traps is what is called the ball valve trap, and is employed in sewers subject to tidal influences. The first one I ever heard of was invented in 1854 by Mr. Rawlinson, C.E., of Westminster, and I give a sketch of it at Fig. 123. As the tide flows into the drain the ball rises up to the dotted lines and presses against the upper seating, thus making the influx of water impossible. When Giant Ocean has done stretching himself, and subsides, the ball falls into the bottom seating, and acts as a stench-trap, by closing up the drain orifice. When sufficient surface water to float the ball enters the grating, by way of the road, into the middle chamber, the ball rises, and allows it to run into the drains. In Fig. 124, the invention of Mr. Tenwick, of Portsmouth, in 1863, is seen another species of this trap. The floating ball is enclosed in a separate chamber, at the side of the trap. At the top of the ball chamber there is a flange, with an elastic seating, and during a tidal or upward pressure of water the ball is pushed up against this seating, and the influx of water or sewerage resisted. When the tide recedes, the whole acts as a normal trap. The buoyant valve idea has since been adapted to sink-traps—viz., in 1866, by a Mr. Williams, in America. This contrivance is sketched at Fig. 125. The ball here shuts the opening against any pressure which might tend to drive back the water from the dip of syphon.

These traps are not efficient in preventing the evils consequent upon sewers subjected to tidal influences—where the tide in fact seals up the outlet twice in each day. The gases are, in such cases, compressed to such an extent that they force the sink and closet traps, and permeate the atmosphere of each house in the wave-washed town. The cure is simple enough, viz., to break the connection of the outlet sewer above the high water line. Towns which are now subjected to the evils of *backwater in the* sewers, are, since attention has been

drawn to the state of Scarborough, rousing up from their lethargy, and at the present time the Town Council of Weymouth are taking steps to construct a dam across the backwater and also intercepting sewers, so as to convey the sewage away from the action of the tide.



126

In case it might interest some reader to know how any material can be carried through a pond or river in pipes with yielding or bending joints, adapting themselves to the bed of a river, we sketch, at Fig. 126, a praiseworthy method of doing this. The pipes are here united by means of a ball and socket-joint formed by making one end of the pipe with a cup-shaped flange. The other end of the pipe is constructed with several ringed ribs, as will be seen in section. The dark filling-in between these is lead packing, which is poured in through a hole, in a molten state. No bolts are needed, and the joint is quite flexible. Nearly a thousand feet of this pipe was laid across the Harlem river in America about six years ago, by Mr. Ward, the inventor. The pipes were in eight feet lengths, and were pushed over into the river bed as fast as the boatmen could run in the lead. So perfect is the arrangement, that were the pipes tinned inside after the newest fashion, and the lead the purest, I believe one could in this way run milk untainted through a tank of sewage. The system has been lately patented in England by Messrs. Ward and Craven.

CHAPTER VI.

VENTILATION OF DRAINS AND SEWERS.

VENTILATING TRAPS, ETC.

ALL theories of drainage which fail to inculcate the absolute necessity of the ample ventilation of drains and sewers are worse than useless, they are even dangerous. So are all schemes which rely solely upon what is called trapping. Drainage without ventilation is erroneous, trapping without proper ventilation is illusory. The recommendation of ventilating does not, however, necessarily mean the condemnation of trapping, although not a few have brought themselves to consider so. Sanitary men are not warring together, under opposite standards, (one depicting a trap and the other a ventilating pipe) as were our forefathers, under the rival coloured Roses. Some theorists have persuaded themselves that the sewers need only be ventilated at the outfalls, and that this compulsory ventilation is sufficient. Others have advocated the forcible shutting out of the sewer air from the house-drains by valves, and have quartered their arms with a flap-trap. But I have never met with architect or engineer who did not insist on the necessity of ventilation somewhere or another—although I have heard of some who have advocated openings in the house-drains at some distance from the house, trusting that these would suck in fresh air wherewith to dilate the foul.

That too much dependence has been placed upon traps is true; but we must not, therefore, scout the use of these contrivances altogether. Closet traps under the basin will always be found beneficial, so will dip traps in the drain of an ice well. An article-intercepting trap will, moreover, be indispensable in some scullery sinks. Syphons, or self-sealing traps will never be dispensed with in wash-basins, even when the waste of these basins deliver in the open air outside the mansion—for a trap of some sort is necessary to prevent the ingress of cold air. An overflow trap for a similar reason is advisable to the

waste pipes of drinking or other cisterns. There is a time to ventilate, a time to trap, and a time to combine the two. Ventilation can be carried out in the wrong place as well as trapping. No wise person would think of ventilating his house-drain in the area pavement. Ventilation may be also superfluous. For instance, a disconnected sink-pipe does not need ventilating by carrying an air-pipe from the trap. A ventilating pipe to a rain-water stack would also be useless. Several writers upon sanitary matters have recommended *all* the house traps to be ventilated; but this, in my opinion, is an unnecessary complication and expense, and is as supererogatory as the attachment of a separate lightning conductor to every chimney-stack.

The ventilation of drains and sewers is the topic now pre-eminent in the minds of anxious householders, for the simple reason, that it has been the thing most neglected. But it is not new, any more than some modern systems of philosophy. It was set aside for a while by the rage for trapping, and has only now re-asserted its proper dominion over such makeshifts. I have pointed out, under the heads of sinks, closets, &c., how such ventilation can best be carried out; but, as illustrating the reasons for such ventilation, I cannot do better thon show how it is regarded from different points of view by very competent authorities.

Dr. Carpenter writes as follows:—

"The principle inculcated is, that it shall not be possible for stagnant air to be ever present in any part of a system of sewers or in any part of a house drain. At certain times, and in some seasons, a very rapid development of sewer gas occurs. It is most likely to happen in sewers containing deposit, or so-called elongated cesspools, but it does occur in sewers which are comparatively clean. Any portion of a sewer or house drain in which there is stagnant air is in a condition for its rapid development.

"The principle which I advocate is, that it should become obligatory upon the owner of every house to have ventilating openings for the protection of every trap; that traps should be forbidden unless so protected, and each should be so constructed as not to be capable of easy removal. The extension of the soil pipe of the water-closet upwards, above the level of the parapet of the house, would provide the most important part. Each pipe may open in the parapet or on the gable end, or on the middle of the outer wall of the chimney, or any where not close to a window. The orifice may be flush with the surface of the wall, the opening being protected by an iron grating similar to those in use over air bricks in the basements of houses. It must be provided, however, that the ventilating pipe be cemented into the wall as nearly straight as can be, and without angles other than the most obtuse."

Mr. Rawlinson says in the same strain:—

"Persons complain that foul smells arise from sewers and drain ventilators, and *stop them up or cry out for* this to be done, forgetting that the escape must be some-

where, and most probably, into the house or houses of those who complain. That foul smells come from ventilators is the best proof that ventilation was and is required; the true remedy will be not to stop up one, but to form a second, a third, and so on, until, by dilution and dispersion at several points (as far asunder as is practicable), concentration in a sewer or drain is prevented, and the sensation of smell ceases. The dispersion of sewer gas will be as the cube of the space around the ventilator, plus any motion of the air by wind."

So again, Mr. Baldwin Latham:—

"If ventilation is not provided, as every drop of water passed into a sewer displaces an equal volume of sewer gas, the gas, if a safe exit is not provided for it, will escape at points out of control and where least suspected. In practice traps rarely exceed a column of water, equal to an inch and a half in height, the majority, as in the case of bell-traps, rarely exceeding one-quarter of an inch. The forces which may be brought into play within a sewer far exceed the resisting power of an ordinary trap, and therefore it should be an infallible rule never to trust to traps unless they are protected by ventilating pipes or some other suitable mode of relieving them from pressure."

Mr. Latham adds:—

"Rain-water pipes ought not to be used as ventilators, as they generally terminate under the eaves, and moreover, when most required, are doing duty in their legitimate capacity.

With reference, then, to the purification of house drains by the above simple kind of ventilation—and as we shall see it is the best—the plain rule is this:—*At the head of every drain, or at the end of every ramification of the drain, fix an upright tube of as near the area of the drain pipe as possible, but at all events equal to half its bore.* This done, the soil pipe ventilated to the roof, the rain water pipes similarly cared for, the overflows' sink and other wastes disconnected from the drain, the house will be safe. *If a sink or washbasin must communicate with the drain, care should be taken to carry a ventilating pipe from the waste pipe out to the open air, and if necessary up to the roof.*

Before I proceed further with what is now considered the orthodox system of drain and sewer ventilation, *viz.*, simple ventilation by upright pipes, ("the true Roman style," as Mr. Latham terms it,) it will be, perhaps, interesting to mention two or three schemes which, although repeatedly slain, are always being perplexingly raised up again. One such system is the lofty chimney and furnace system. In the year 1869 Mr. Kenworthy took out a provisional protection for a system connecting all drains with ventilating pipes leading to the furnaces of boilers—ignorant that such a treatment was no novelty. The idea, of course, is to force the furnace to draw on the sewer for the *air necessary* for combustion, the decomposition of the

sewer gases occurring at the same time. It has been given in evidence by Mr. Simpson, however, that an experiment of this kind was tried at a soap works at Southwark some time ago. The sewers there were connected with the furnaces, and the result was a serious explosion. Mr. Rawlinson is of opinion that the effect of such furnaces would be next to nothing. Mr. Latham estimates that, even under the most favourable circumstances, and granting that the ventilation would be efficient, which he does not, for 1,500 miles of metropolitan sewers 230 chimnies and furnaces would have to be erected, at a cost of nearly half a million sterling, and that annually there would have to be consumed coals worth over 200,000*l.*

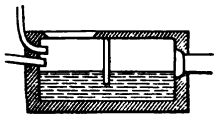
There must have been something radically wrong, however, in the case of the Southwark experiment; for, at some sewage pumping stations, the sewers and sewage tanks are partially ventilated in this way, for the simple reason that they might just as well be so as not. It is very common to hear the so-called advantages discussed which would result if all the house drains were ventilated by way of the house chimney flues. Whatever these may be, one great disadvantage would be that on very many occasions the rooms would be inundated with sewer air.

The vacuum system of ventilation is also another of these half-slain theories. In December, 1871, Mr. Gibbs proposed to lend, free of charge, a number of fans, so as to draw the air out of any foul sewers, and produces there a downward instead of an upward current. Mr. Haywood, however, pointed out in reply, unless every inlet, every gully or air-hole were stopped up, most effectually, that when the air exhauster was set in motion, the air currents would set in with great velocity towards it from the nearest inlet, the current becoming feebler and feebler from other inlets as the distance increased, until, practically speaking, the exhaustive power would become inoperative. These and many other schemes I could mention are all of a halting description.

The best place to ventilate the sewers is at intervals in the crown of the sewer, and for house drains by means of vertical pipes against the houses. Tall shafts and Archimedean screw pumps as used at Liverpool cannot be so effective.

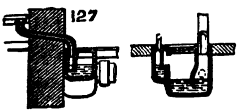
I pointed out in chapters v. and vi. how sink-pipes and soil-pipes *should be ventilated*, and I will now explain what has been hitherto done

under the head of ventilating generally, and what schemes have been proposed. I will also indicate where they are obviously faulty.

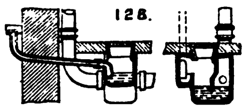


126.A

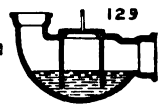
An attempt at ventilation is shown at Fig. 126*a*. What is radically wrong is the discharge of the sink pipes inside the trap, instead of above the gratings. With this exception this form is the readiest method of disconnection, when no iron or earthenware traps can be got, and it can be built of brickwork and have the interior cemented. If a trap is unnecessary, and some think so, the slate diaphragm can be omitted, and the outlet pipe laid in close to the bottom.



127



128.



129

Fig. 127 exhibits cross sections of Mansergh's ventilating trap, made by Mr. Jennings, of Lambeth, and which is intended to relieve the house drains from the varying presences of the deleterious gases. The article here drawn illustrates a trap to be fixed in close proximity to the house wall. The smaller pipe conveys the waste from a sink or bath; the larger pipe is the ventilating pipe, which may be either the rain-water stack, or a separate shaft. The surface water is received into the centre of the trap, through the grating between these two inlet pipes, shown on the right-hand section. The trap, as will be noticed, is twice trapped—that is to say, the sink pipe is trapped separately, above the drain outlet pipe.

Fig. 128 represents a trap of this description, for use in the centre of a yard, in an area, or stable, &c., and the trap body can be removed to any distance from the main walls. Where it may be found inconvenient to make use of the rain-water pipes as ventilators the house drain can be ventilated by a separate piece of gas piping, and taken up the buildingas before. The above traps are made of earthenware. It is sometimes unadvisable to disconnect the drain pipe quite close to the house, and if it is intended to carry out this disconnection and ventilation at some little distance in a proper manner, such a trap as this will be most suitable. But if this

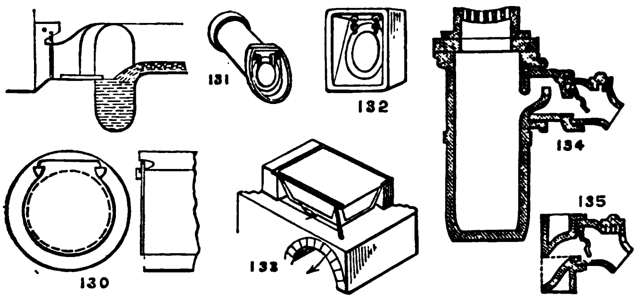
is all the disconnection and ventilation intended for the house drain it will be altogether deficient. A safer form of trap to receive the rain-water and sink-pipe waters is given at 95*a*, page 40.

Mr. Cottam, of Oxford Street, London, the well known improver of stable buildings, about five years ago introduced to the public the patent effluvium trap, which I give at Fig. 129. A double diaphragm, forming an intercepting chamber, is made in the trap; and should any sewer gas return through the water there, it is passed up the pipe, over this intermediate chamber, as it bubbles up. This trap is intended for a stable or cowhouse, but even there it will require a much larger ventilating pipe. Very often mistakes are made as to the sizes of these pipes. I have seen an inch tube fixed to a 6-inch drain-pipe; and a gas tube of small diameter attached to a 4-inch soil pipe, is an anomaly which can every day be witnessed. As a rule, the ventilating pipe should be of the same bore as the pipe to be ventilated. It is unwise, moreover, to imagine that the double dip in the trap will prevent the escape of foul air up the inlet. Still, with a ventilating pipe of commensurate size, the above trap would be very useful. So would the improved form shown at Fig. 146*a*, page 61. Neither, however, must be considered as carrying out a sufficient disconnection from the drain. If the top of the trap were covered throughout with a flat grating it would serve admirably as a gulley trap to receive the rain-water or waste-pipes delivering their contents about a foot or so above it.

There is a kind of trap called a valve trap, which is claimed as a ventilating medium, but it must be on the *lucus a non lucendo* principle, for it does not ventilate, and is chiefly used for preventing the ventilation of the sewers into the house drains. These valves or flap traps are preferable to the syphons Figs. 42*a* and 42*b*, page 16, for the reason there stated. It is compulsory to have a flap trap fixed in the sewer at the outlet of house drain, and the sewerage authorities usually have the sewer broken into and these valves inserted by their own workmen.

Mr. John Martin was the first to introduce the valve system for closing the ends of the pipes used in draining into sewers. His valves were constructed of slate or glass, hinged in the simplest manner. He claimed by their use not only to shut out smell or air from the sewers, but by means of their self-acting valves to ventilate the

passages. Fig. 130 exhibits his system as published in 1847. The well-hole which received and intercepted the silt and gravel, and thus acted as a dirt-box, is shown in the upper part of the drawing, with the grating removed, and below is a representation of his valve and its hinges.

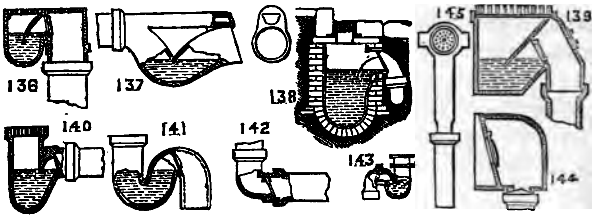


Figs. 131 and 132 represent the present forms of valve traps, and as made by nearly all the earthenware pipe-makers. Each manufacturer's trap has its individuality, which lies in the mode of hanging the flap, and all kinds are more or less effective. Where stoneware is used, the surface is ground. The flaps are now made of galvanized iron, fitted sometimes with gun-metal eyes, (in the manner shown at Fig. 131,) and at other times with chain rings, as drawn at Fig, 132.

I interpolate here, and sketch at Fig. 133, an American system of self-closing traps for the inlet of road drains, where the usual wells and water traps are dispensed with. It was invented in 1861.

Fig. 134 gives a section of Doulton and Co.'s road gully, and is similar to Fig. 110, page 45, but with a valve trap in combination with the ordinary syphon trap, thus affording, up to a certain point, a double security. The same idea is embodied in the sketch Fig. 135, which represents their combined valve and syphon trap block with inspection hole and cover, and this is used in gullies which are built up of brickwork. When flaps are used in sewers there is undoubtedly a great deal to be said in their favour; but it can hardly be termed anything save carrying out a crotchet to insert them in the smaller sized gully traps. Fig. 134 represents, however, a gully 4 ft. deep and 18 in. diameter, and Fig. 135 an outlet

to join with a 6-inch drain pipe, and such may be wisely wedded to a valve in the manner shown.



The constructors of some of the before-described contrivances do not pretend to ventilate the drains by the use of the valves, and claim only to shut out the sewer air, but in 1858, Messrs. Lovegrove and Jennings introduced a system of ventilation into the sewer by means of valves, which we will now briefly describe.

These gentlemen's patent area sink trap is shown at Fig. 136, and consists of a syphon trap, working in unison with an air valve. Under the grating at the top is a partition, and the refuse water has to pass under this into the drain. The air valve behind this, and depending over the downlet into the sewer, is said to allow fresh air to pass into the drain whenever the pressure of the external air exceeds that in the drain. The whole apparatus is covered by a grating, and this takes up a space of about 11 inches by 5 inches, the depth of the trap from grating to bottom of syphon being 8 inches.

They also patented an earthenware syphon trap for the junctions of house drains with the sewer on similar principles, the ventilating agent consisting of the variation in the temperature of the outside air and that of the sewer. This trap is seen at Fig. 137. The cast-iron valve, of which an end elevation is also figured, prevents any sewer air from passing into the house drain; should, however, the pressure of the air in the drain exceed that in the sewer, the valve, it is claimed, opens automatically, and allows the air or gas to travel in an opposite direction. Their patent gully trap, Fig. 138, embodies the same idea—whenever a partial vacuum exists in the sewer, the air supply valve opens and establishes the equilibrium, but immediately shuts whenever the tendency of the air is to rush up the gully grating to poison the atmosphere outside. A stable or other

trap on this system is shown at Fig. 139, the trap being formed as in the sink trap, Fig. 136, only with a straight apron piece. The size usually made has a grating of about 11 inches square, and the whole is 13 inches deep from grating to bottom of syphon. A garden sink, with a circular perforated iron grid, embodying the same reasons for action, is drawn at Fig. 140. At Fig. 141 is also to be noticed a sink syphon trap, constructed for and adapted to existing inlets where this patent system is wished to be adopted, and yet so as not to disturb underground relationships. The size usually made is 15 inches deep and 20 inches across from outside to outside of the inlet and outlet pipes. Nor does the application of the system end here, for at Fig. 142 we show a trap expressly contrived for the ends of rain-water pipes. For small waste water pipes a miniature syphon apparatus, 6 inches square, is also made, and a larger trap of the same construction is sold for ordinary purposes. The form of these traps is shown at Fig. 143. All the above goods have inspection covers. Four years later, in 1862, Mr. Lovegrove patented some extensions of the above system, including air supply valves, where the drain was ventilated above the roof, and also exit valves where the drain was ventilated into the sewer.

Fig. 144 represents an air-supply box, made to build in with a wall; and where there is no wall, an air-supply post is provided, as at Fig. 145—the ears being intended for fastening to the supporting uprights. All the above goods are manufactured by Mr. Jennings, of Lambeth.

The above traps are worthy of attention, although no doubt constructed upon a forced system, as the air will not naturally follow the course of the sewage. The air in the house drains will only pass into the sewer when forced by the pressure caused by the increase of water in the drain, and when the water traps are strongly sealed with water. It is good that the compressed air in the drains should force a valve and escape into the sewer, rather than bubble up through the hydraulic seals of the house traps; nevertheless, it is far better that both drains and sewers should be so well ventilated by means of shafts that these valves would not necessarily be required. The above system has many patrons, and to leave it out in a dissertation upon sanitary appliances, however hurried, would be reprehensible.

If any reader should adopt this kind of ventilation, or indeed any

other which throws a strain upon his house traps, he ought to be certain that these house traps are well sealed and in good working order. But, as I have endeavoured to point out, no water trap can for a long time resist the pressure of a gas anxious for liberation. The simplest proof of this is the experiment pointed out by Mr. Baldwin Latham:—Insert in the cork of an ordinary Florence flask a tube of glass, bent like a syphon, and fill this trap with water; the warmth even of the hands will soon so dilate the air in the flask as to force out every drop of water.

PRICES OF THE ABOVE VENTILATING TRAPS.

		s. d.
Fig. 127...	With loose grating, to stand against house wall............	12 0 each.
	If with cast-iron raising piece and loose grating	12 9 "
	Ditto ditto ditto, and locked grating	13 6 "
Fig. 128...	With raising piece, and loose grating to stand away from house wall..	12 9 "
	Ditto ditto ditto, with locked grating......	13 6 "

Plates for reducing sockets for small ventilating pipes, 1s. extra.

	3	4	5	9	12 Inches.
	s. d.	s. d.	s. d	s. d.	s. d.
Fig. 129	17 6	30 0	50 0	90 0	140 0

	4	6	9	12	15	18	Inch bore.
Figs. 131 and 132	s. d. 4 0	s. d. 5 0	s. d. 7 6	s. d. 12 0	s. d. 25 0	s. d. 40 0	Each.

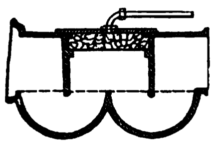
Fig. 134	Fig. 135	Fig. 136, for 4-in. pipes.	Fig. 137	Fig. 138	Fig. 139	Fig. 140	Figs. 141&142, for 4-in. pipes.	Fig. 143	Fig. 144	Fig. 145
s. d.	s. d	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
40 0	12 6	12 6	12 6 to 15 0	15 6	17 6	9 6	5 6	8 6 to 10 6	4 6	7 6 Each.

DEODORISING TRAPS.

The necessity for fitting up the ventilating openings in the sewers with disinfecting or deodorising materials very soon became evident. Such openings were too few in number, and the foul gases had time to

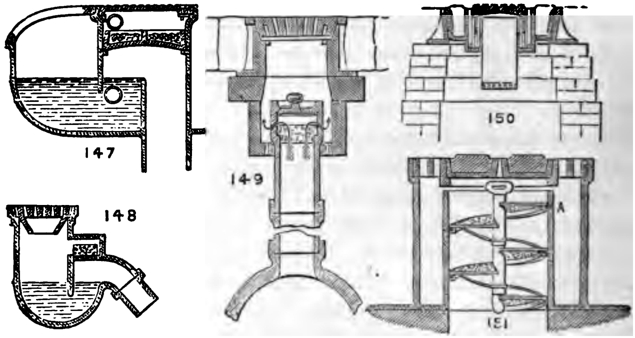
generate. I fear that the openings will always be too few, and that deodorants will always be necessary in ventilating the sewers. They will, at all events, be so for many years to come, and until every house is made to ventilate its own portion of the sewer, without an interposed flap trap.

The reader would be tired with a history of the many methods of supplying deodorising materials to the drains. There has been a regular succession of schemes broached, and faster than could be profitably explained have the different high priests of Hygiene slain their pet bullocks on the Sanitary altars. Drain pipes have, figuratively speaking, been turned inside out. Tanks have been contrived over the sewers with self-feeding plugs; and they have also been constructed so as to run out more of the chemical fluids during the time of day when the discharge through the sewers is greatest. These tanks have also been fitted with glass gauges, to show the quantity of the fluid contents; and, in fact, ingenuity has so tickled the matter as to provoke even amusement.


146

Not only were sewers fitted up as deodorents as time rolled on, but the benefits were soon extended to the traps of the house and stable. Fig. 146 gives an instance of this, and represents the present form of Mr. Cottam's effluvium trap, as fitted with a tray of oxidising material. With such a tray the ventilating pipe should even be larger than usual; anything less than four inches would effect but little good.

An apparatus providing for the ventilation of the sewer up the rain-water pipes, *after* the air of the sewer has been deodorised by passing through a metallic perforated box containing charcoal or other powder, is drawn at Fig. 147, and is the invention of Mr. Whitelaw, of Dunfermline, who introduced it to notice in 1858. The reader will notice that as the surface water from the road runs through the curved and hinged grating, it falls into the trap body, and passes down the discharge duct to the drain. The lower inlet between the two diaphragms is to conduct the rain-water from the roof into the trap in the ordinary way. A good feature in this trap lies in the connexion of the upper inlet pipe with the rain-water stack, and this *above* the deodorising box. By this means the more or less purified air from the drains is taken up to the top of the buildings *and discharged into the air.*



As another example of those gully or road traps, made to discharge the gases of sewers after deodorising them, and where these gases must perforce pass into the atmosphere through the charcoal box only, or are intended to do so, we may notice that lately introduced by Messrs. Brooke and Sons. This is sketched at Fig. 148. If preferred, the deodorant could be placed in the rain-water pipes, and the gas discharged into the air by way of those pipes; or the patent provides for the use of special pipes, to be fixed against the buildings. The discharge pipes may also be placed in the chimney flues. The above contrivance, as adapted for syphon traps, and as drawn, is, however, faulty, inasmuch as when the trap loses its water seal much of the noxious gas obtains a highway into the exterior air, free of any chemical toll. A similar idea, which they patented a year previously, in 1865, and which is largely used, is figured at Fig. 149, and represents a direct method of ventilating the sewer without the adjunct of a water trap. The top socket of the upright pipe leading into the sewer or drain is fitted with a galvanized iron screen full of charcoal. Between this deodorizing receptacle and the cover to the pipe, which cover acts both as an inspection plate and a means of warding off the road grit, and wet, and several circular openings are made, and through these the deodorized gases pass to the external air. The grating at the top surface of the road is also a lock-grate. Nothing appears simpler, and I understand that it gives satisfaction. I cannot, however, discover sufficient accommodation for the surface water or road dirt. In some circumstances, the water

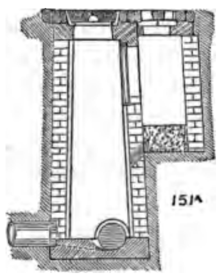
holes would be speedily clogged, and the water forced through the circular openings,—the consequence of which would be the expulsion of the oxygen from the charcoal, and a suspension of benefit.

Mr. Lovegrove has also contrived a disinfecting charcoal box for sewer ventilation, fitted with a trapped overflow, on his patent system previously described; and details and prices of this can be had from the maker, Mr. Jennings.

Fig. 150 exhibits a section of a sewer ventilator, patented in 1869, by Mr. Jacob, C.E., Bromley, Kent. An outside frame of iron is made to set in brick or stonework, and in the centre of this frame is a space for the insertion of a cylinder which is charged with materials for oxidiation, and covered with a cap as protection from wet or dirt. The idea is to purify the sewer air in its escape to the road level, and doubtless this is at times effectually done. But the objections to the ventilators drawn at Figs. 148 and 149 find here also an illustration, for although the small surface chambers would act well in moderate weather, after a heavy rainfall, the water would undoubtedly find its way to the charcoal with bad results. Unless also the deodorant box fitted most accurately into the inner frame, the gases will sensibly escape at all times, and largely so during the earlier part of the day, when, owing to the large flow in the sewer and the compressed state of the sewer air, every vent is, so to speak, an upcast shaft in miniature. The inventor may, however, since have remedied these faults.

The most perfect ventilator which I know is drawn at Fig. 151. It is the invention of Mr. Baldwin Latham, of Croydon, the experienced civil engineer, and patented by him in 1869. Here an outside ring of iron is attached to an inner one, and the space between them constitutes the sludge-box. The area left in the centre of this angular dirt-box is the well-hole leading to the sewer, and the sewer air would, therefore, naturally escape at the small apertures left at the sides of the top cover, immediately over the dirt-box. But by the adoption of the spiral tray of gauze covered with charcoal, which is fixed gently sloping, to the central stem, and rests loosely on the top edge of the small square spiral trough underneath, the sewer air is thoroughly oxidized before it reaches the external atmosphere. The surface water falls into the sludge-box, and when it rises to the point A, it enters the small square spiral trough and *runs down into the drain*, without any saturation of the deodorizing

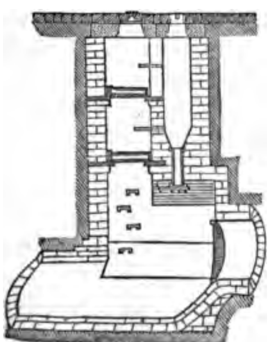
material. All the noxious gases from the sewer, undergo, therefore, a compulsory purification by passing through the charcoal, &c., before they escape from the upper grating. The objections to the ventilators previously figured and described are here anticipated, for the water which enters the ventilator is carried through the spiral trough without contact with the charcoal, and no gas whatever can rise to the road level without oxidation. This contrivance is so admirable, that, in one well constructed and tended, even the gasophaner would hardly detect an escape of sulphuretted hydrogen. The gasophaner is a curious, but uncommercial article, made of boracic acid mixed with salt, and blown into a glass tube. Sulphuretted hydrogen, for instance, would immediately pit this tube over with small holes resembling those made by small-pox, and soon destroy it altogether. The best test for this gas is to dip a piece of blotting-paper in a solution of sugar of lead; the action of the gas will blacken the paper.



151A

Fig. 151*a* represents the usual method of ventilating and deodorizing pipe drains, and here the charcoal screen is placed vertically in the partition between the manhole and the smaller ventilating chamber. I copy this figure from the "*Suggestions relative to Sewage,*" prepared by Mr. Rawlinson in 1867.

At Fig. 151*b* is exhibited a manner of carrying out the ventilation and disinfection of brick sewers, from the same authority. Across the shaft are laid two moveable filtering screens, loaded with charcoal. The foul gases are obliged to enter these before they can get into the open street by way of the side ventilating chamber and open grating. Any solid matter, such as road grit, washing into the gully or ventilating chamber, can be removed at the bottom of the chamber.

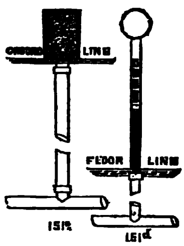


151B

I have figured this kind of shaft here, because it illustrates the manner in which

the gases are made to find an exit at every ventilator, even in a hilly town. To prevent the gases accumulating at the upper parts of the district, what is called a "tumbling bay" is formed—that is, one part of the brick sewer is built at a higher level than the other, and a flap trap is fitted to the upper one, thus compelling the oxidation to be carried out at each ventilator. In both the above arrangements the manhole cover fits tightly in its place.

A more elaborate system of ventilating and deodorising the sewers was patented by Mr. Harrison, of Liverpool, in 1869, but it is on so large a scale that it is not suited to this work. However, if any one wished to construct a manhole into an underground sewer, with a ventilating cover, a sludge-box, a deodorising screen, an overflow out of the manhole, a flushing valve with a portable winch to raise it, a flushing box for flushing out the main drains, and lamp accommodation, all in one apparatus, the above patent is well worthy of his attention.



A novel system of rendering the drainage gases innocuous is sketched at 151*c*, and is the improvement proposed upon the underground trays by Dr. Taylor, of Anerley.

Fig. 151*d* embodies the same idea. A ventilating shaft is provided with gratings, and on these are placed canisters containing charcoal. The top is also furnished with a perforated sphere, to insure the proper dilution of the escaping air.

It will be observed that charcoal—wood charcoal—is the material almost invariably proposed to be used in the deodorizing and disinfecting trays. The merit of the discovery of charcoal as a means of destroying the mephitic gases and vapours of sewers, is due to Dr. Stenhouse, who exhibited the first charcoal air filter at the meeting of the Society of Arts in 1854. The change is effected after the manner of a slow combustion. Six years after, Mr. Haywood, the engineer of the City of London, commenced experiments with 104 of these medicated air shafts, spread over a space of fifty-nine acres, in the poorest, narrowest, and most crowded part of London, and the result was so successful that it has been ever since relied upon.

Charcoal plays a very prominent part in many proposed dis-

infectants; and not later than last year, Mr. Stanford patented the charcoal produced from seaweeds and ordinary charcoal mixed, as a suitable material for this purpose. Mixed with lime, it has been used for precipitating the fertilizing matter of sewage waters; and, in combination with salt, it has been broached as a disinfectant of the more solid sewage, and as a material to put into the chambers of street gullies, and in trays, at intervals, in the main sewers.

That universal material, peat, was declared also to be useful in this way; and, some eighteen years ago, Mr. Dimsdale claimed, as a disinfectant and absorbent of the noxious gases, all those peats containing salts of iron, (common in many places over the country) either mixed with alkaline or earthy matters. It appears to have been long a practice in Ireland to use peat, or peat and ashes, and also peat charcoal, to mix with the manures for the purpose of fixing some of the gases, and patrons of this system are to be found all over the Continent, and in America. Lime forms, of course, a large ingredient in some disinfecting processes. Mr. Vertue, some years ago, proposed to run liquid lime into the sewers through separate pipes communicating with store tanks and kilns, but the expediency of this idea was greatly questioned.

Reverting to charcoal, which after all is the chief material in use, it may be useful to know that an admixture of chloralum with it renders it the most active deodorizer and atmospheric purifier known. The charcoal should be steeped in chloralum, and then drained. The solution attracts moisture and absorbs ammonia most greedily. An ammonio-chloride of aluminum is thereby formed, and this may be utilized in various ways. Repeated experiments have proved the superiority of the above mixture, and I am satisfied that, at all events in most cases, it will be found preferable to pure charcoal.

Before closing this chapter, some notice ought to be taken of the newly introduced salts of Mr. Cooper, of 28, Duke Street, Westminster, as having been found especially serviceable in the matter of keeping the streets in a healthy moist condition. Mr. Cooper's salts have just undergone a crucial test by the Westminster Board of Works, and have proved in every way valuable. The salts are chiefly chlorides of calcium, sodium, and aluminum mixed. By watering the roads with these deliquescent salts, the dust is not only laid but fixed to the ground, and much extra labour and expense in frequent

watering is consequently saved. The street, farmstead, or stable-yard is also by their use considerably disinfected, and the ammoniacal dust prevented from rising to the level of the pedestrian's mouth, as is too commonly the case with even the germs of virulent diseases. Who can tell what mischief is at large in every cloud of dust that one encounters. How distressing even, were all danger known to be absent, are dusty roads and parterres around a mansion. It is because these annoyances can be mitigated by the sweep of a hose attached to a garden engine full of water, charged with a little of these salts, and because I can bear testimony to their efficiency, that I have here mentioned them.

In case any one considers such treatment over-fastidious, I append here a part of the report of the Medical Officers of Metropolitan Board of Health of New York, upon the subject of road and street dust, which I think will convince him that watering is absolutely necessary:

"The dust of the streets in its finer or coarser particles according to the height at which it had been collected, with a large proportion of organic elements; particles of sand, quartz, and feldspar; of carbon, from coal-dust, and lampblack; fibres of wool and cotton of various tints; epidermic scales; granules of starch of wheat, mainly the tissues of plants; the epidermic tissue, recognised by the stomata or breathing pores vegetable ducts and fibres with spiral markings; vegetable hairs or down, either single or in tufts of four or eight, and of great variety, and three distinct kinds of pollens. Fungi were abundant from mere micrococcus granules to filaments of mould. When water was added to a portion of dust from whatever source, and exposed in a test tube to sunlight or heat for a few hours, vibriones and bacteria made their appearance, and the fungous elements sprouted and multiplied, showing that they maintained their vitality, and proving that the germs of fermentation and putrefaction are very widely diffused."

CHAPTER VII.

WATER CLOSETS AND URINALS.

WATER CLOSETS.

WATER-CLOSETS instead of being regarded as important parts of an establishment, are too often hidden away in improper nooks. For instance, they are placed at the far ends of close corridors, under the staircases on each floor, on the half-space landings—its only door facing the hall; in corners of bath rooms and billiard rooms, and between bedrooms—in fact, in every conceivable improper place. Who that has visited Edinburgh, and domiciled for a night or two at a certain Princess Street hotel, but recollects the small unventilated closets, lighted by gas only, which daily "testified of themselves" in the abominably narrow passages, and also in the very sleeping rooms. Contrary to all this, the closet should be fixed in a place set apart. In designing a house, its site demands careful attention. The best position is an isolated building, built tower fashion, with closets on each floor, and the supply-cistern on the top. This tower can be connected to the house proper by a passage with two or more doors, like an ice-house approach, or there can be an anteroom with double doors. The windows of this divided passage or anteroom should, if possible, range on both sides, reaching to the top of ceiling; and, if this is not convenient, narrow air-bricks should be inserted in the line of cornice. The closet itself should have double hung sashes, extending nearly to the ceiling, the upper panes filled with ventilating or saw-cut glass, and a narrow fanlight surmounting the frame filled with wire gauze or perforated zinc. This treatment would compel a ventilation despite of all carelessness. Air-bricks would serve the same purpose, but the foregoing is, I consider, preferable. Or the upper sash could be drawn down a few inches, and a fillet nailed on the stiles to prevent its being closely shut. The light to the closet *should on no account* be a borrowed one, as is nearly always the case

in railway stations, but the windows should be built in an external wall, the closet seat facing it, and the exchange of air taking place between it and the door.

The above rules may be considered sumptuary, fit only for large mansions, and inapplicable to the majority of dwellings. This may be so for a little longer, but the time is speedily approaching when the arrangement of the house generally, and the position of the closet especially, will be made a matter of scrutiny by the surveyor appointed under some stringent Sanitary Act. To ensure the isolation of the closets by a passage or an anteroom is not so difficult or much more costly than the accommodation which they now receive. In many cases a fourth part of the cost of external meretritious ornamentation would have erected the closet tower and provided the apparatus as well. How often, to hide the anomaly of a water-closet in the hall or staircase, do we find a door rich in stained glass and heraldic arms; the *open sesame* is not, however, as might be supposed, into a conservatory of delights, but into a sanctuary of smells.

It is difficult to advise the occupier of a house in which the atmosphere is poisoned by misplaced closets how best to remedy matters; but the foregoing remarks will, I trust, be of some assistance. If at all possible, project a building out from the house, large enough to form an anteroom, or ventilated vestibule, between the house and the closet. The first cost will speedily be repaid in the increased health of the occupant and his family, and huge interest paid as well, so long as all is kept in perfect order. If a tenant merely, the landlord should be appealed to at once, and if his refusal to allay the nuisance is persistent, or a reasonable overture scouted, a fresh domicile should be found, no matter at what inconvenient distance.

Even when the site is perfection, and the closet built in the best imaginable manner, there remains a something else to be done. There is, for example, the soil-pipe to be certain about. This pipe should be made of cast lead, well tested by temporarily soldering up the bottom orifice and allowing it to stand for a whole day full of water, when if it show no sign of leakage, it is fit for use. It should also be carried up through the roof, all the same diameter, and rise moreover to the highest part of the roof. This will enable the house drains to be properly ventilated at a most important place, and where, in fact, the only *direct* connection exists between the house and the

drains, for the sink and other wastes are supposed to be disconnected therewith as before shown. It will also be preferable to ventilating the soil-pipes by horizontal pipes under the closets. The pipe from the closet trap can then be joined to the soil-pipe without interrupting the withdrawal of the sewer gas. No gas will then push up against the syphon trap, and wait to pay toll at that or any other tollbar when a highway has been constructed for its especial use.

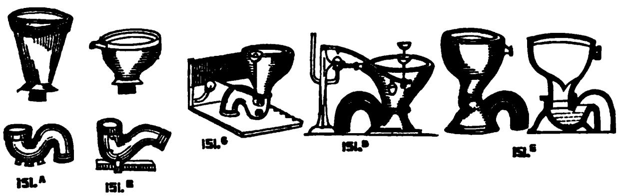
If the soil-pipes inside a house are formed of earthenware, remove them, and substitute good cast, or best soldered milled lead pipes. If the soil-pipe is enclosed in a wooden case, with the gas and water-pipes climbing up alongside, like ivy stems up a tree-trunk, see at all events, that the whole are water-tight, and either hinge the case-cover, or make it easily removable by screws. Should the soil-pipe be buried in plaster, as is too often the case, cut it bare, overhaul it carefully *in situ*, and cover it with wood only, if at all.

A most pernicious practice is the emptying of slops into the closet, instead of into a proper basin, such as is drawn at Fig. 92, page 38. The result of such a custom is, that the closets speedily acquire a foul smell, and, upon removing the framework, it will be found that the wood floor is saturated, or the zinc safe filled with a filthy liquid. Were there even an overflow to this zinc tray, and not merely a few inches of accommodating sawdust, it would be bad enough. Some housemaids, to obviate the possibility of overflowing the basin, lift up the handle whilst emptying their pails, ignorant that they are filling the house with sewer gases, if the soil-pipe and pan are unventilated. But what care can combat the evils which a careless domestic can bring about. The apparatus may be the best and strongest, and the workmanship perfect, but before long a bent lever or a leaking valve will index the delinquent. The carelessness of menials has become such a conviction with some gentlemen, that to ensure cleanliness they will daily inspect the servants' closet themselves. I know this to be the practice in several establishments.

Before entering upon the subject of the closet apparatus, a few words as to the seat. This should be so framed as to come asunder easily, the riser to slide up and the seat to slide out. The lid should have a hole in it just over against the pull-up handle, so that the pan can be discharged when the lid is down. This may appear *extra fine* treatment, but it is only a cleanly habit, and is easily

learned. In a pan closet which clogs with soil, and which, when moistened by the trapping water, generates a foul smell, such a plan would be useless for the gas would only accumulate to salute the next occupant. Of course, as a disagreeable smell would rise from such a closet, whether the trap below the receiver was ventilated or not, the only cure would be a new apparatus.

I will now describe the various forms of closets, for I am convinced that too much ignorance prevails concerning their construction, and, indeed, for the matter of that, the words, "there is something the matter with the closet," is too often a prelude to an extravagant bill from some designing plumber.



The commonest kind of closet is the round hopper closet pan, which is fixed into an ordinary sigmoidal bend. The two parts are shown at 151*a*. At 151*b* is given an oval apparatus of the same character, but with a somewhat improved trap. These closets are too frequently used even in the best houses for servants' use, where, accord- to experience, the better automatic closets should be fixed. They are also not unfrequently fixed where the water supply is scanty. On the contrary, unless worked by a very high pressure of water, these simple closets invariably get foul and emit a most offensive smell, Another basin of this description is shown at Fig. 151*c*, and is also chiefly used in the basement. The water is introduced by raising a handle fixed on the seat, the lever of which acts upon a valve and thus allows the water to flow through an aperture in the back of the basin. A return rim on the edge of the basin prevents any overflow upon the seat.

Another example of a syphon pan closet is given at Fig. 151*d*, and is made and sold by Messrs. Patten and Co., of London. This varies only from the foregoing in the outline of the base, which is larger and firmer. The handle in this case also acts upon a lever beneath the

seat, which in its turn raises a valve and admits the water wherewith to flush out the basin. What is called the "Paragon" closet is shown in elevation and section at Fig. 151*e*. Here a diaphragm of pottery is introduced at the interior foot of the basin, above the trap, on the supposition that this will hide the contents of the syphon. Unfortunately, however, it forms a ledge for the soil to rest upon, and also retards the effectual flushing of the pan, unless it be accomplished by a great waste of water. I cannot recommend this pattern to the householder.

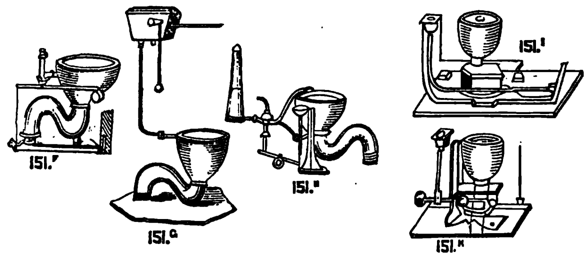


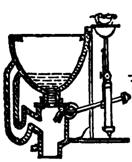
Fig. 151*f* exhibits an enamelled iron hopper closet, and in the sketch here given the water is supplied to the basin by means of a wire which passes beneath the floor, connected with the door and also with the supply valve. The flushing water is discharged every time the door is opened. The supply of this water can also be regulated to a nicety. This apparatus would suit the servants' closets very well indeed; but I am not prepared to recommend iron, however well enamelled, for closet pans. The peculiarity of the closet figured at Fig. 151*g* consists in the addition of a water supply box, or waste preventer, of galvanized iron. This is kept always full by a self-acting ball valve. The pulling of the wire works the lever projecting from the side of cistern, and this in its turn actuates a lever inside which opens the supply valve, and runs off a certain, but of course a limited, amount of water into the earthenware hopper. Where the supply of water is circumscribed, some such contrivance is useful. Especial care must, however, be taken to keep them out of the reach of frost.

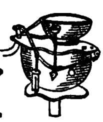
It can easily be imagined that a constant supply of water would *only form an inducement* to waste it, were the flushing of closet

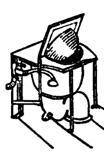
basins carried out by taps from the main pipe, as was at one time a common practice, and still is, more particularly with the ordinary hoppers for cottage use. A patent closet, known as Mr. Common's, which has been much lauded as preventing this waste, is drawn at Fig. 151*h*. Here the water runs directly from the main into an air-vessel of cast iron, and compresses the overlying air to such an extent, that when the handle on the seat is raised the water is forced to flush out the pan. This flushing is somewhat fierce at first, and afterwards subsides almost into inefficiency.

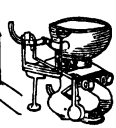
What is called a Bramah's valve-closet is rudely shown at Fig. 151*i*. This was the first valve closet ever brought into use. It is now considered somewhat complex and heavy, yet has nevertheless its partizans. All the better class of closets in mansions built about twenty or thirty years ago, will be found mostly supplied with this pattern. A simpler apparatus, upon the same principle, and known as an Elastic Valve-closet, is exhibited at Fig. 151*k*. Like the last mentioned it is furnished with a lead D trap, usually placed between the floor joists, and a valve is provided in a small cast-iron box placed immediately beneath the outlet surface of pan. The water is introduced by a lever and bell crank, which opens a valve in the cistern above and also the outlet valve at the bottom of the basin. The valve of the basin has sometimes ground fittings, but is now generally fitted up with a vulcanized indiarubber bedding, thus insuring noiseless action. This closet has been in use for many years now, and has given general satisfaction.

The above five closets are all supplied by Messrs. Tylor and Sons, of Newgate Street, London.


151.l


151.m


151.n


151.o

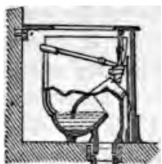

151.p

Underhay's regulator valve closet is drawn at Fig. 151*l*, and here no service box, cranks or wires, are at all required. A number of these closets can also be supplied from one cistern, and from any distance. The fixing is, moreover, excessively simple. At Fig. 151*m* may be

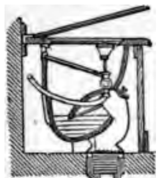
seen what is called a pan closet, fitted up with Underhay's regulator. This kind of apparatus is called a pan closet because the usual soil container is made gas-tight by a pan made of copper acting as a receptacle for the water which traps the closet basin. The soil-pan is kept in position by a spindle which passes through the iron container beneath, and a lever from which keeps the soil-pan to its proper bearings. I cannot recommend these pan closets, and my chief objection is, because, at every discharge of the soil-pan, a large quantity of foul gas is emitted from the container below. It has, moreover, no feature of excellence which is not better embodied in some of those previously mentioned.

The next depicted closet, Fig. 151*n*, is known as the patent tip-up closet of Mr. Jennings, Lambeth, and is peculiar in its construction and action. An enamelled iron pan is screwed to the underside of the ordinary seat, and has an outlet of about four inches diameter. When the seat is down the pan rests inside an under container, which receives the soil. There is also the usual syphon trap. An insurmountable objection to this closet is the facility which it offers to the escape of foul air. Each time the seat is raised in order to discharge the pan, the foul air generated in the receiver rises up and constitutes not only a nuisance but a source of danger. Another closet of Mr. Jennings's, which he has named his valve, "Closet for the Million," is drawn at Fig. 151*o*. It consists of the usual earthenware pan, provided with a water supply flushing-pan under the top flange. The soil outlet of this pan is at the base, and the pan is moreover placed in a cast-iron stench trap arrangement, somewhat like an ordinary D trap. Immediately beneath the outlet of the pan, a flap-valve of india-rubber is made to fit into the outlet, or under side of the basin. This valve, worked by lever and spindle, is so balanced by external and weighted levers, that only a certain portion of water can rest in the pan, and at times the pressure bearing the valve to its seat is so little that it is liable to give way and discharge the water from the basin. Both the above closets are, in my opinion, unworthy of Mr. Jennings's reputation as a sanitary reformer. His best closet is the patent valve closet and trap, shown at Fig. 151*p*. This closet and trap is formed in one piece, of the best white ware. The pan has a side outlet leading through a conical valve and seat *into* a syphon below, thence into the soil-pipe. It is cleaned by

means of a flushing-pan, placed as usual, and supplied by water by raising a handle in the usual way. This is a most cleanly and excellent apparatus.



151.p



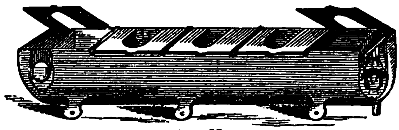
151.q

151.r

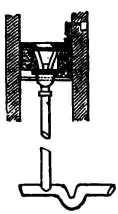
A closet of later invention is shown at Figs. 151*p* and 151*q*. These are called the "Holborn closets," and consist each of a glazed earthenware pan with a syphon base as shown. Neither valves or any kind of machinery are exposed to the action of the soil or water, and another admirable feature in both is the inspection plate at the front of the trap, the removal of which facilitates the removal of any stoppages. The closet Fig. 151*p* is worked in this way. When the closet is in use the pressure of the seat upon the plunger shown under the seat keeps the valve closed; but when thrown out of use the plunger gradually rises again and admits just the necessary flushing water. The soil is, so to speak, driven out of the trap by the action of a water lute at the back. Fig. 151*q* is differently worked, and the water is admitted into the pan by pressing down a knob placed within the dish upon the seat.

The apparatus sketched at Fig. 151*r* is known as the "Universal closet," and consists of a roomy pottery ware basin, resting upon a cast iron stench trapped base. The *pulling up* of the handle in this case effects the flushing, and not the *pressing down*. The supply valve is fitted with a regulator, adjustable to any pressure of water. In this closet also an inspection door is placed on the trap, so as to permit of the soil pipe being cleared out without unseating the closet, or sending for a carpenter. Another practical feature in it is that it stands on its own base, and needs no propping up. All three of the above can be adopted with success. They are manufactured and supplied by Mr. B. Finch, of the Holborn Sanitary Works, London, and are the *patents of Mr. Stidder.*

The foregoing may be said to represent the closets now in use in the majority of houses, but there remains a class of apparatus chiefly designed for workmen on a farm or factory of any kind, which I must allude to in order to render the series more complete. This is known as the Water Closet Range, and an illustration of the system is given at 151*rr*. Familiarly speaking, it is a trough with an egg-shaped bottom, deepest at the discharge end. The egress pipe at the lower end has a socket valve, acted upon by a lever in the usual manner. The water supply is at the highest part of the trough, and consists of a service pipe with self-acting ball-cock apparatus. If there is a sewer the connection therewith is made at the lower end of the trough, or if none, the soil can be discharged into an ashpit or dry earth receptacle. The sketch here given shows a closet range for five persons, with seats merely, and without partitions for privacy, but these last can be fitted up in a variety of ways. In the north of England this kind of closet is much used, and is reported to be well adapted for poor neighbourhoods. I believe, however, that they have been declared unsuitable for camps and barracks.

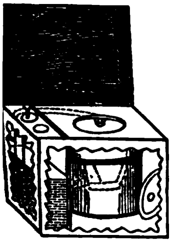


151 RR

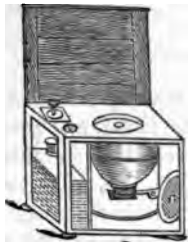


151 ff

I have not as yet mentioned a water-closet where a deodorizing material was used; but at Fig. 151*ff* is exhibited a section of that just now patented and brought into notice by Dr. Taylor, of Anerley. An improved pan, with a top flange, is here fitted into a surrounding filtering chamber, containing charcoal. The closet is otherwise constructed as usual, and the drain below is likewise furnished with a syphon. The novelty lies in the means taken to withdraw any gases which may be generated in the pan, or creep up by the soil pipe. This is ensured by ventilating pipes, which lead from the pan under the upper flange, and pass up the wall and through an opening into the outer air. Any escaped gases in the neighbourhood of the closet-trap would be similarly purified. The first drawback which I can see to such an apparatus would be the difficulty of repairing any accident to the *working parts* without having to empty the deodorizing chamber.



151.s



151.t

There remains a word to be said by way of conclusion about the portable water-closets. These are useful in cases of sickness, but ought to be used only in conjunction with the best disinfecting media, and should be immediately emptied ter usage. At Fig. 151*s* may be noticed the portable closet of essrs. Tylor & Sons, with earthenware basin, copper pail, cistern d pump complete, all fitted in a deal or mahogany case. Fig. 151*t* Stidder's patent portable closet, manufactured by Mr. Finch. The int between the pan and the receiver is here formed by a water-lute ade in the pottery. A trap valve is also affixed to the basin ttom, to prevent, as far as possible the smell from the receiver neath. The chief difference between these is that the former has basin of metal and the latter an earthenware one. For invalids se, arms can be attached to rise in place when the lid is lifted up.

PRICES OF WATER CLOSETS.

151*a* and 151*b*	151*c*	151*d*	151*e*	151*f*	151*g*
s. d. 7 0 and upwards.	*s. d.* 15 6	*s. d.* 30 0 to 37 0	*s. d.* 30 0 to 37 0	*s. d.* 30 0 to 33 0	*s. d.* 43 6

151*h*	151*i*	151*k*	151*l*	151*m*	151*n*	151*o*
s. d. 38 0 to 48 0	*s. d.* 78 0 to 83 6 *	*s. d.* 58 6 to 66 6 *	*s. d.* various.	*s. d.* 38 0 to 46 0	*s. d.* 63 0	*s. d.* 42 0 to 105 0

151*p* (Jennings.)	151*p* (Finch.)	151*q*	151*r*	151*s*	151*t*
s. d. 60 0 to 120 0	*s. d.* 48 0 to 52 0	*s. d.* 36 0 to 42 0	*s. d.* 55 0 to 90 0	*s. d.* 58 0 to 115 0	*s. d.* 90 0 to 100 0

* *Spring valve, &c.,* lead D trap, and lead service box, 35*s.* extra.

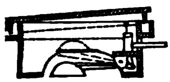
URINALS.

Nothing better indexes the sanitary condition of an establishment than the state in which these are found, and nowhere does cleanliness better repay the outlay. Too often the servants' offices are fitted up with mere slabs of stone or slate, and with open sinks, which omit the direst smell. I consider it within the province of this treatise to mention, at all events, a few of the best of these conveniences.

Urinals, fitted up with water-flushing supply, have been more or less used for many years past, but little notice was taken, until very lately, of the offensive smell given off by the absurdly large area open to the flow of the urine. This fault was especially patent in the older railway stations. The first improvement consisted in the attachment to the wall of a receiver, such as is shown to suit angles, at the upper part of Fig. 151*u*. This has a perforated inlet pipe all round the top margin, by which means the whole surface is, or ought to be, washed. The lower sketch represents a flat-backed receiver. At the lower part of both there is an outlet grating through which the waste passes direct to the drain or soil-pipe. The water is supplied to these articles in divers ways, by stop-taps just above the receiver, by self-closing valves in the same place, and sometimes by means of a loose foot-grating, which sinks about half an inch when trod upon and opens a water supply valve. The flushing water in this case runs whilst the weight is on the grating and ceases when the pressure of the foot is removed. This is called the treadle motion supply. At Fig. 151*v*. will be noticed an arrangement of this sort. The same mode of supplying the cleansing water is made to 151*w*. which represents Mr. Jennings's patent lipped urinal. Messrs. Macfarlane's urinals are too well-known to need any description of mine.

A considerable improvement has been effected in these articles, as in all other sanitary appliances, and Mr. Finch, has manufactured

rge quantities of the urinal, sketched at 151*x* and 151*y*, in side and ›nt elevations. Here a carefully constructed stench-trap is pro-led, immediately beneath the brass grating of the receiver. iis grating can be kept locked, and the same key fits an inspection or, which, when open, enables the trap in the waste-pipe to be amined. All these urinals are made in white pottery ware, or in hite enamelled iron.



151z

I cannot forbear giving at Fig. 151z an improvement just made by Messrs. Finch and Stidder, upon the treadle motion supply, but it is one of considerable importance, as prevents the sloppiness and smell at the flow line. The improve-ent I allude to consists of a lute or channel around the interior and p edge of the treadle frame. This contains the water which would herwise soak into the floor, and cause both smell and rottenness. s will be observed, the treadle plate is furnished with a flange upon s underside, which dips into the waste liquid and so forms a trap. ny surplus water passes through a small trap provided in the soil-pe, and so precludes the possibility of smell there. This is called e patent water-lute urinal, and I have seen it work admirably.

The dry earth and ashes system is now extended to the urinal, and self-acting supply apparatus is sold by Mr. Heap, of Manchester. perforated iron foot-plate is pivoted to lever bars, at the end of hich weights are fixed, which counterbalance the pressure of the et on the plate and cause a delivery of earth. If economy is very esirable, a galvanized guard of iron and perforated foot-plate only eed be purchased, and these can be fixed over a pit built of brick-ork, 3 feet square and 3 feet deep. But this last is not automatic, nd the freedom from smell can only be secured by throwing into the ault or pit daily a suitable quantity of earth or ashes.

PRICES OF URINALS.

151*u*	151*v*	151*w*		151*x* and 151*y*
		Basin only.	Complete.	
s. d.	*s. d.*	*s. d.*	*s. d.*	*s. d.*
15 6 to 21 0	57 6	30 0	40 0	24 0 to 36 0

CHAPTER VIII.

EARTH CLOSETS, ASH PITS, AND ASH CLOSETS.

EARTH CLOSETS.

SOME writers have not hesitated to characterise the earth closet as a perfect *panacea* for all our sanitary evils. The Jewish Law-giver Moses, in the book of Deuteronomy, specifies the use of earth as a deodorent. The Chinese, of course, are said to have used it from time immemorial, just as they are said to have slung suspension bridges on chains before Mr. Telford spanned the Menai Straits, or Mr. Ordish the Moldau, with his improved rigid structures. It is doubtful, too, whether or not Sir Henry Lawrence found it in native use in India before he simplified it for barrack use, or before Dr. Ogilvie's and Mr. Moule's perfected systems were introduced into the various presidencies.

During the last twenty-five years the earth closet has been in constant use in the rectory at Woodstock, in which town Mr. Parker now carries on its extensive manufacture.

The earth suitable for use in these places is to be found in nearly every field and garden, and should be of rather a loamy nature if possible, but still porous. A very sandy soil is next to useless, and peaty earth has been known to engender fermentation. Dr. Buchanan remarks that clayey or loamy earth, and more particularly the brick earth of the drift formation, is the best for the purpose. Large heaps of the earth should be collected for the year's use, and dried in the summer sun, and if this be impossible, owing to want of storage, it can be dried in small quantities upon a tray made to fit under the fire-bars in the house grates, or in the greenhouse. Drying stoves, specially constructed for the purpose, and costing from forty to fifty shillings each are sold by the Moule Closet Company. As a general rule, however, if earth is spread out upon hard ground, in the sun, it will soon dry. In some of the closets it is not so needful to use per-

ectly dry earth, but it is always best to use it, and that, too, after aving been well sifted in a small sieve of about three meshes to the ıch. It will otherwise cake and cling to the walls of the hopper, or ıll into the pan in awkward lumps, not so well adapted for the eduction of the fæces to powder during the action of drying. The upply earth to the hopper should moreover be strictly looked after, ınd as regularly so as the winding up of a clock. Slops should never e thrown into the closets. As for the quantity of earth needed for ach operation, about one-and-a-half pints would appear about the verage.

It is quite a matter of option as to using chemical disinfectants ith the earth, but, of course, *all possible* smell would be thus voided. Carbolic powder, if the odour is not objected to, would ıswer very well. So would peat ashes, charcoal, or gypsum. hloralum powder has been already much used and reported upon vourably for use in these closets. The earth treated with this wder absorbs and retains the ammoniacal compounds in a soluble rm, and therefore well suited for plants. It furthermore keeps the rth odourless when drying, and does not hinder that process.

When the earth is removed from the closet it should be spread out dry in the air, under a shed, roofed over, but well ventilated at e sides, and ten to twelve weeks' exposure will enable it to be used er and over again, until a valuable manure is formed. It is ıestioned whether the system *pure et simple* would work well in pulous places, and whether some modification of it would not be tter—such for instance, as that published by Mr. Bannehr, in 1867. The advantages claimed for the earth system are many, and nongst others the following:—that it leaves unpolluted the natural rings and watercourses; that it allows the rainfall to be collected in pure state; that it is a great saving of water, and, unlike the water oset, is independent of winter frosts; that it is inexpensive and not pt to get out of order; that it dispenses with underground drainage, r considerably narrows it down, and robs it of its danger; that it enerates no smell; that it is an auxiliary to health, or rather a revention of zymotic disease; and that it is a source of profit to its atron, either in money or in increased farm or garden crop.

Having penned this rather common-place Hymn of Praise to Mother Earth, I will now give a description of some of these earth closets.

They are not many in number, and I shall not figure them all because a few of them are more suited to the fastidious requirements of a model museum than to the rough-and-ready services of every-day life. I mean this remark to apply to the working machinery of the closets, not to the amount of finish given to the envelopings, for, as a rule, the simplest closet is sold in mahogany as well as in other fancy casings.

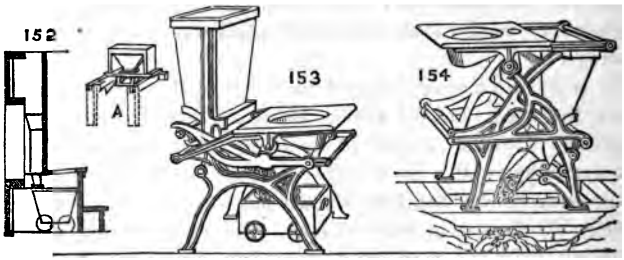


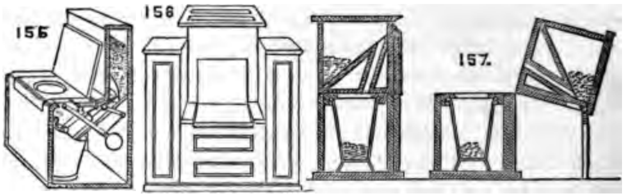
Fig. 152 gives an idea of the common cottage or factory form of closet, made by Moule's Patent Earth-closet Company (Limited), of London. The tank on wheels underneath the seat is called a "Broadmoor" tank, and these are made to hold from 35 to 45 charges. What is called the "Commode" tank, holds about 25, and the "pails" about 15 charges. The tanks can be removed from the back, the front, or side, as may be ordered. The apparatus for working the supply of earth to the tank may be a pull-out, a pull-up, or a self-acting apparatus. The detached sketch A shows a pull-up apparatus. This company also fit up closets on different storeys, having a common soil pipe, which may run down inside or outside the building as may he specified.

At Fig. 153 and Fig. 154, I give illustrations of Colonel Baird's patents, made and supplied at the Collinge Engineering Works, Westminster-bridge-road. Fig. 153 represents the apparatus for fixing in an ordinary closet where there is no pit made underneath. The deposit here falls into a waggon which is drawn out and emptied when required, as in Fig. 152. When the seat is depressed or in use, the lower part of the valve rises and hits the under side of the hopper framing, thus agitating the earth and causing it to settle down *towards the opening.* Fig. 154 exhibits a closet of this patent, con-

structed to stand over a pit, and the deposit in this case is removed through a trap-door made at the back of the building. The earth is also supplied from the back of the building through a trap-door in the wall. To render the closet private, a boarded partition is erected between the pan and the hopper; this we do not show in our sketch. In each of these patterns the apparatus consists of a cast-iron frame, bolted together with iron stays, supporting a cast-iron valve moving on two pivots beneath a zinc hopper containing the earth. This valve is made to receive exactly the proper measure of earth, and is worked by the weight of the sitter by means of a lever and friction roller. On rising, the lower part of the valve falls, of its own weight, the upper part slides back under the hopper, and at the same time, the measure of earth which has fallen is cut off and thrown along the moveable shoot.

The Engineers of the Moule Closet Company, previously mentioned, Messrs. Girdlestone, have made some important improvements during the last two years, in the apparatus for distributing or casting a regulated supply of earth in these dry closets, but they are of too technical a description for these pages. Mr. Bostel, a plumber, of Brighton, also introduced a patent closet in 1869, and here the soil falls on a table, and by pulling up a handle a scraper passes across the pan or table, and removes the soil into a shoot. A supply of dry earth is at the same time delivered to the shoot, and when the scraper moves back some earth is deposited on this reception table or pan. The earth is measured out between two slides in the shoot; and smells from the soil, or rising currents of air through the shoot, are prevented by plates of iron and by the position of the scraper. I believe that Mr. Bostel has just concluded some improvements in these closets. Another patentee, Mr. Joseph Heap, of the City-road, Manchester, has also brought out a very good closet of this description, the chief features of which consist in the peculiar damper for regulating the quantity of earth, and in an arrangement for sifting the earth in case it is too wet, or of a mixed and fibry nature.

The designs Fig. 155 and Fig. 156 represent Parker's Patent Automaton Earth Closet, manufactured by him at Woodstock, Oxfordshire, and here the earth shoot moves out of the way when the pressure is upon the seat. Fig. 155 illustrates the ordinary chair pattern; *but his* 1A chair pattern is a more finished article,



being panelled throughout, and also made with an easy slope to the back. Fig. 156 shows a closet of this description for indoor use, made to resemble a chest of drawers, when the top flap is pulled down upon the seat. The earth hoppers are in the wings. He also sells a cheap out-door closet, made for fixing over a pit, either single or in rows, being in fact a skeleton apparatus. The whole are made self-acting.

The Americans are not a whit behind us in these closets; and I cannot forbear figuring at Fig. 157 what must surely be the *ne plus ultra* of simplicity in a portable earth commode. All valves and mechanism are repudiated, and nothing more elaborate than a pair of hinges can be found about it. I show it both shut and open, and in the latter state the action of the leg support is worth pointing out The lower part of the closet is shaped in the stereotyped way, and contains a pan, with a seat over. The seat cover, however, consists of a box containing the earth, and in this box is formed a hopper, with a passage between. When the cover is thrown back the earth gathers in what was at first the highest part, but now the lowest part, and will be exactly over the passage, and ready to precipitate the regular and sufficient quantity of earth the moment that the closet is shut up. The earth, therefore, in this instance, is deposited through the aperture of the seat direct upon the refuse. The inventor is a Mr. Newton, of Newport, Rhode I., U.S., and he is the third American who has patented an earth closet in our islands within the past twelve months. Messrs. Clark and Aiken's device has, however, more to do with the delivery of the earth in given quantities at the proper time, than with anything else, excepting, perhaps, that the earth is delivered by turning once round a crank like that on a barrel organ. The closet of the other welcome invader is, however, too elaborate for these pages, and I will therefore not describe the action of its levers *or its rods, its slides* or its flaps, or anything that is its.

157A

Not unfrequently the artizan class manufacture these earth closets for themselves. To show how simply they can be made, I give at Fig. 157*a* a section of one of this class. A revolving quadruple chamber is here fixed in the bottom of the hopper feed, and a turn of a handle will empty one of the chambers of its contents.

I ought to add, in case it may not be generally known, that whether there be a local act or not, earth closets and the like are now legal-ed by Act of Parliament, July 31st, 1868, cap. cxv. sec. 7, for use towns or cities.

In isolated buildings, or if preferred, even in crowded places, it ould be quite easy to collect all the slop and waste water and run it f into proper earth tanks. The sink waters would in this way cause o smell whatever, and would enrich the soil to a wonderful extent, could be repeatedly proved. Farm buildings, and even cow-houses nd stables, could thus be made perfectly free from smell, provided, course, that the earth system was also adopted in the closets. In me parts of England the earth system is already adopted in the rainage of cow-sheds, piggeries, slaughter houses, and in such cases e fæcal matters are drained into a water-tight pit, with earth platorms on each side, and the system is reported to work excellently ell, with proper care.

Mr. Heap, the earth closet manufacturer, already alluded to, thus escribes his plan for the removal of the house slops on the earth rainage system. He says: "These can be treated with, simply and ost effectually, by having to each house, in connection with the drain, cistern with a perforated false bottom—the upper chamber to be illed with cinders and charcoal. Into this the slops are emptied day y day, and are to a great extent purified before entering the drain; nd with reference to private houses, or private institutions, the same plan can be adopted, or should there be sufficient land or garden attached, the slops can be conveyed in ordinary 3 in. drain-pipes in various directions, giving them a fall of not less than one foot in fifty, and laying them not less than 16 in. below the surface, keeping the joints 1½ in. apart. At each joint a slate or piece of thin stone must

be placed, both top and bottom, leaving the sides open so that the matter can ooze out. At certain places small cemented vaults must be constructed for reservoirs. In these the solid substances are contained, and they can be emptied periodically." But as he leaves one to infer afterwards, a great deal will depend upon local surroundings, and the presence of main drains and sewers, as to whether the interception of the waste fluid will be worth the outlay.

ASHPITS AND ASH CLOSETS.

It would be a waste of space to enter upon the many evils which resulted to the community where the old-fashioned privies and ashpits, middens and *necessaries* were paramount. Neither need I describe them, for they are unfortunately not yet expelled from many hundreds of towns throughout the land. It would appear, however, that not entirely to this generation can be given the palm for the discovery of their unhealthiness, for long before the invention of any of the improved privies and ash closets, attempts had been made in the deodorization and disinfection of these places. It was even anticipated that by the adoption of some of these palliatives that the ashpit arrangement might be made a permanency and the cost of laying down sewers obviated.

It was a practice fifty years ago to throw a quantity of oil into the cesspits, just as finings are put into casks of beer, with a view to confine the smells arising from the putrefying matters; but, as the difference of specific gravity prevented a proper mixture of the mass, Mr. Browne, in 1850, invented a disinfectant fluid more suitable for for this purpose, consisting of oil and water made duly alkaline, the result being a milky fluid that would better amalgamate with the *olla podrida* in these receptacles. Mr. Bobœuf afterwards discovered that vegetable and mineral oils containing saponifiable acid formed a means of purifying these heaps of filth, but in its turn the specific was superseded.

A more solid treatment of cesspools and similar places was published in 1855, and this was the calcining, powdering, and mixing with the soil and putrescent matters there, the mud of ponds or rivers, this seemingly assisting to disinfect by absorbing the humidity and holding in durance the stronger odours. In a similar manner, Mr. Corne *introduced* to notice a composition made chiefly of anhydrous plaster

nd coal tar mixed with a little salt and oxide of iron, this he declared o be a good disinfectant for these infectious localities. Amongst ther solid *panaceas* may be named that of Mr. Thomlinson, which onsisted of powdered gypsum heated and well mixed with tar and hen ground to powder; also, the recipe of a Mr. Moret, which was he crushing, after heating, of a gray mineral found in France, called "deterso," and which, if it performed a third part of what was claimed for it, ought to rank almost next to salt. More respect might be paid to the proposal of a Mr. Sant Agata, who recommended cockle and other sea shells to be stoved and powdered, and mixed with half the quantity of sulphate of iron, thus producing an ochrey nodorous powder, so powerful, he claims, as a disinfectant, that one part of it need only be used to 100 parts of decomposing matter. In 854, Mr. Herepath claimed the discovery of the coke of Boghead coal s a suitable absorber of foul smells, &c., and Mr. Gwynne published luring the previous year a system of deodorization of feculent matters y the use of finely powdered coal. But somehow or another the above were never brought into regular use, or rather the water-closets replaced the privies at a faster rate.

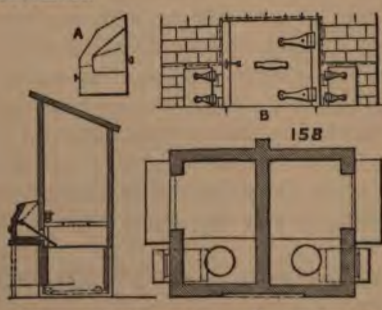
Mr. Hughan, about two years ago, patented a system of deodorizing and solidifying sewage and filth by mixing these matters with Portland cement, and when set, crushing the mass into powder; he calls the product a carbonic acid guano. In the same year, Mr. Dewar monopolized the right of mixing animal excrement with gaswaste, adding to it in some cases soot or pulverised slag. This last-named material was also brought under the notice of Messrs. Spence, and in 1870, these gentlemen obtained letters patent for the treatment of slag, top cinder, or Blackband ores, with one or two acids, and so producing some salts of iron for general use. The use of ores, for instance, the hematite of iron ore, mixed with the residual solutions run from stills in making bleaching powder, was known before in the manufacture of cesspool deodorizers.

Amongst the simpler kinds of disinfectants formerly used for such places may be named, peat, charcoal, lime and tar.

Common salt also was long held in high repute, and formed the chief ingredient in the deodorizing and disinfecting powders of Mr. Crews. Spent tan, too, found a place in the galaxy of Colysis, as did also sawdust. This last material, mixed with a fifth the quantity of nitric

acid, and a little more than this last portion of sand, was suggested by Mr. Lynen, as a good disinfecting compound.

After all, the improvements suggested upon the construction of the old-fashioned ashpits and cesspools are very few indeed. The first attempt of this description was made by Mr. Brown in 1850, who proposed to erect over them a cistern containing a disinfectant. A pipe was made for drawing up the matter by means of a suctional action pump, and the disinfectant was made to flow into this pipe, whilst the soil was being withdrawn, thus "joining issue," as the lawyers say. By this means he made almost immediately an artificial manure, especially as he mixed the disinfected refuse with a carbonaceous powder. The artificial disinfecting fluid, which he used, held an oily substance in solution, in combination with a metallic salt. Quite a different system was that of Mr. Abraham, published in 1854, and altogether mechanical. In his cesspits he erected an upright shaft or pipe, having perforations which extended from their outer to their inner surfaces in an oblique direction. These upright pipes were made to drain the cesspools of any superfluous water; and if the drains themselves wanted cleansing, they were flushed through these vertical pipes in the ordinary way. I think, however, that, beyond keeping the ashes out of the drains, very little benefit was thus obtained; and I mention it merely, because, after all, it was an improvement.



158

159

Ashes constitute an excellent absorber and deodorizer, but cannot, however, rival the dried earths. Still they are frequently used on board steamers, and are highly spoken of. The ash closet may now be said to monopolise the market in certain northern manufacturing

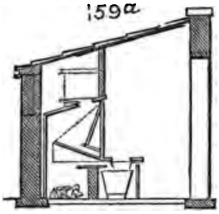
stricts. It is, in some cases, perhaps, more suited to the poorer
ellings in a town as yet unconnected with a sewage scheme, than
earth system—for the ashes are of home manufacture whilst the
earth would have to be purchased from a hawker.

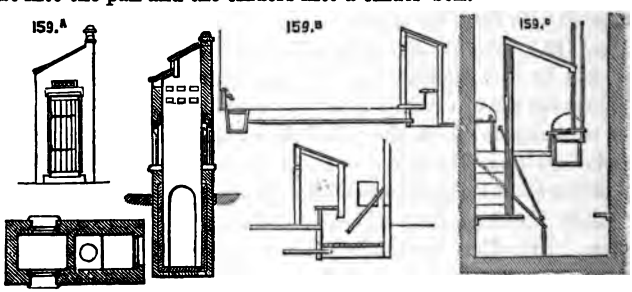
A section of a patent dry ash closet, and a plan showing two of
em (fed at the sides) for semi-detached houses, are drawn at Fig.
8, and this represents the closet patented by Mr. Macleod, and
rgely manufactured by Messrs. Macleod and Sanders, of Salford, in
ncashire. The back or side of the closet is fitted with an ash
reener and distributor, and these most useful contrivances are sold
parately, as sketched at A. In the closet apparatus the ashes are
rown into the hopper, and the finer portions fall through the sieve
d are guided underneath, and either spread direct upon the soil, or
distributed when the closet is used, by means of a handle or by a
ing working in unison with the seat or with the closet door. The
ders fall into a compartment of the box, so as to be reburnt; and,
needed, another division can be added for the reception of broken
tery, &c., for repairing the roads and other uses. A few hold-
ts of iron attach the box to the wall. At B is shown an elevation
the emptying door for tank—the two side doors being for the re-
val of broken pots, &c. The cinder and ash screeners are in this
se at the sides of the building, as seen on plan. What a boon,
mpared with the filthy ashpit.

Fig. 159 represents Mr. Duncan's patent cinder-ash closet, made
d sold by Mr. Hammond, of Warley, near Brentwood, in Essex;
d here the use of earth is not to be recommended—a fall of ashes
ly requiring to be in the pail before using. This is the simplest
oset of the kind. The hopper or earth reservoir is suspended from the
p of the closet back, and has a false bottom with a central aperture,
y which a certain heap of ashes, and no more, falls on the true
ottom. By pulling the handle the concussion of the hopper striking
gainst the casing is sufficient to throw out and distribute the ashes.
The employment of sifted material is here not compulsory, and even
tones could be mixed with the absorbent material, which in this
closet is also very fairly distributed over the soil. Besides the above,
there is an ash closet known as Weare's, in use at Liverpool.
The essential difference between it and other closets is, that the
shutting of the lid distributes a disinfecting and deodorising powder.

At the Social Science Congress held at Leeds, in 1871, Mr. Morrell, of Ducie Buildings, Manchester, exhibited an invention of his which I give at 159*a*, and which has received great commendation. Through the opening in the back or lower wall the unscreened ashes are thrown, and pass through a screen into the hopper below. When the closet is used the seat is depressed, and this in its turn imparts a shivering motion to the screener, which serves the purpose of sifting the cinders from the ash dust, whereupon the dust falls into a measurer. When the occupant rises, the contents of the measurer is spread over the soil in the pan, and the cinders are at the same time delivered into the receptacle behind, ready to be reburnt. Mr. Morrell proposed to supplement an insufficient supply of ash finings by the finer street sweepings. Such an arrangement as the above is certainly a great improvement upon the ordinary ash-pits and closets, and is admirably adapted for the use of separate cottages on an estate. A portable commode, on the same patent principle, was also introduced by Mr. Morrell, and it differed from the Duncan ash commode, Fig. 159, in being so constructed as to receive unscreened ashes at the top, and deliver the dust into the pan and the cinders into a cinder-box.

159a





At Nottingham, some little time ago, the town Sanitary Committee established in some districts the ash closet, which is figured at 159*a* in the above group. As will be observed by the plan, elevation and section, a pit is formed, having watertight walls, under the whole closet. The floor of the pit below, which is also watertight, slopes on all sides towards the centre, so that the latest deposit of soil will be

covered by the next supply of ashes. It is also so constructed, that not only are unusual facilities given for emptying the pit, but the height of the ground line, and the position of seat and door, prevent any overchargement of the vault. According to the authorities, a privy of this description, nine feet by three feet on plan, would cost about £10. The lower sketch at Fig. 159*b*, exhibits an ash pit, &c., patented, in 1866, by Mr. Wheelhouse. Under the seat is a false floor, with perforations to allow the moisture to run off. The ashes are guided exactly under the seat by the diagonal partition, and in this united way the soil is kept comparatively dry, and no premium held out by dilution in water to the formation of sulphuretted hydrogen and other gases. The upper portion of Fig. 159*b* represents his patented method of flushing an ordinary privy, which is, by placing a cistern, with a perforated cover, below the road line under a pump or tap, and connecting it to the pit by a pipe. This cistern may be supplied with lime or some other disinfectant. The pipe which runs from the underground cistern may also convey flushing water, mixed with a disinfectant, to the ash closet with false bottom previously described.

A totally different attempt to work a sanitary cure in ashpits, &c. was patented by Mr. Turner, of Leeds, in 1868, and of this I give a section at 159*c*. Here, the fæces are collected in an earthenware cistern, and the urine conducted therefrom to the space below the cistern, where also the ashes are thrown. The cisterns are placed at such a height above the road, that when the sliding door, which is formed in their sides, is opened, the soil can easily be scraped into a cart. Of course, the ashpit proper does not require such frequent emptying. A row of the above privies are so constructed, that the night-soil men have only to open a large door, and back in their cart, and the ashpit can be cleared out in a remarkably brief space of time, Nor is ventilation forgotten, for, as will be observed, a large flue is carried up from the back of the seat, and this is taken to the chimney top, or to the highest part of the house adjoining. The updraught of this flue serves to keep the closet clear of foul smell, and will mostly do so. A disinfectant is, however, discharged into the cistern at every time of using, being shaken out of a roller-shaped contrivance every time the lid falls down. The lid is compelled to fall and deliver the powder, for a block is nailed to the back of the seat so that the latter

is never at right angles, or able to stand erect. A fluid disinfectant can also be used in this closet.

PRICES OF EARTH AND ASH CLOSETS.

	Plain Deal.	Painted or Varnished.	Grained.	Teak, Oak, Walnut, or Mahogany, and polished.
	s. d.	*s. d.*	*s. d.*	*s. d.*
Fig. 152 (*see Note a*), each	45 0	65 0	...	125 0
Fig. 155 (*see Note b*)	40 0	43 0	47 0	80 0
Similar kind, but with sloping back and panelled, &c.	55 0	60 0	70 0	110 0
Fig. 156	90 0	95 0	120 0	160 0
Fig. 159 (*see Note c*)	50 0*d*	77 0*e*	...	120 0
Figs. 153 and 154	60 0 each. Wagons 10 6 extra.			
Fig. 158 ...*30s.* each and upwards.	Screening apparatus, *21s.* complete.			

a—If self-acting, add *5s.* each. Each price includes a pail.

b—If with pail, add *5s.* each. Skeleton Apparatus, *25s.* to *35s.* each.

c—Hopper and iron-frame work for fitting to existing closets, *35s.* each.

d—If with galvanised iron shoot, and with flap instead of a moveable cover-lid, add *13s.* each.

e—If with self-acting apparatus, &c., as in the mahogany one, add *25s.* each.

For other prices enquire of the makers, whose names are given.

I have given the earth and ash closet systems somewhat in detail, because I have used them with success in isolated places, and consider that they have much good work to perform. They are necessarily great improvements upon the cesspool and midden practices, and should in all cases replace them, until a thorough water drainage is effected. When this last is reached, they may wisely be dispensed with. I know that there are many, however, who advocate the exclusive use of the earth closet in our towns and cities. But how would it work? Take for example, Norwich, with, say, 17,000 houses and 75,000 inhabitants. Mr. Broadman calculated that in order to do justice to the system, the town would have to be divided into four first-class and eight second-class districts, and an immediate outlay of £4,600 be made for horses, vans, pails and drying kilns. The annual cost of collection and management, with the cost of the earth, would be about £8,500. The estimated profit at 20s. per ton, or 6s. per individual, would be about £14,500, but this is evidently very much exaggerated.

And what would such a condition of things necessitate. There would be, for instance, 8,000 or 10,000 pails to cart away from the

ıck doors or front areas of the first-class houses, at least every third
.y, and in the second-class districts, where the closets were down-
ıirs, and a fortnight's accumulation could be allowed, there would
about 130 tons of manure and earth to remove daily. This is in-
pendent of the return journies with the dry earth. One cannot
r a moment consider that any Board would undertake such a busi-
ıss as this. I think that it would prefer to wait for the profits which
tilization will some day bring, and in the meantime build sewers,
nd push on with the water carriage system. In favour of the earth
ystem, is undoubtedly what the poor cottager would make by the
ıle of his soil to the market gardener, or the reduction of rates, which
ight follow a good management by the authorities. But when the
ttager enters the city, he perforce relinquishes his pig-feeding and
ıer little money-makings. Another consequence of our sewerage
stem is that we are unable, as in Paris, to lay the water-main,
e gas-pipes, and the telegraph wires in our sewers, which we could
if we adopted the tub principle in use there, or collected the
ght-soil on Mr. Moule's plan. We at all events save the inter-
inable nuisance of hand to hand collection, and, I believe, avoid also
ı infinity of smells.

The heaviest objection to the adoption of the earth closet in towns
, however, made by Dr. Parkes, in questioning that the earth treat-
.ent prevents the production of the emanations which produce fever
ıd disease. It is admitted that the compost is deodorized, but is it
isinfected? Until this can be conclusively shown, it would be idle
› agitate for its more general use, or its adoption, Maine liquor law
ıshion, in our towns and cities. Were it even proved that the pesti-
ential evolutions disappeared with the odour, there must always
xist cities too vast for its successful practice. How could we expect
hat London could set apart 400 acres each year in which to dig three
eet deep the two millions of cubic yards of earth which Mr. Bateman
stimates would be required under the earth closet system. To bring
he earth from a distance would be still more undesirable in point of
economy.

Mr. Bannehr, formerly the co-patentee of Mr. Moule, has lately advocated a totally different system of treatment of ordure, which demands mention. He lays particular stress upon the collection of the urine, which is, he urges, not only the chief evil agent in perco-

lation into wells, but is also the more valuable product. The proportion of urine to fæces voided is, he urges, as ten to one, and the value of each ton of the former being about twenty shillings, his scheme is worth attention. The difficulty would lie in the separate collection of the urine; but this must be accomplished automatically sooner or later. I do not think, however, that it will be collected in order, as Mr. Bannehr proposes, to dessicate it into a dry concentrated manurial powder, but rather for the abstraction of its ammonia. The solid excreta was proposed by Mr. Bannehr to be dealt with in such a way that it must necessarily be sprinkled,—not with dry earth, for he seceded from that system,—but with a carbonaceous disinfecting powder; and he exhibited a model of the necessary machinery, which is reported to work well. The latest modification of the dry process is the Carbon-closet system of the Carbon-closet Company of Leeds. In these closets charcoal is used, and the quantity necessary to produce the proper effect is less than a fourth the quantity as compared with earth. It is well adapted for factories and places where water-closets would not be available. The carbon closet system is without doubt the best dry process yet invented.

If common sense or economy, however, points to the sewerage principle as the most feasible one, there is one of its concomitants which calls ringingly for redress, and that is the present arrangements made for gathering the household dust and ashes. If a person accustomed to a constitutional walk before breakfast time avoids an occasional accident from the exposure of the many shaped boxes of dust, he may consider himself lucky; but if he escape the inhalation of some disease from the well-packed weekly hampers of dirt and offal, he is doubly fortunate. This latter evil is, unquestionably, to be remedied by the use of some deodorizing disinfectant. What is to hinder, for instance, the compulsory use of a dust collector which shall, every time the ventilated lid is opened, disperse a certain quantity of some suitable powdered disinfectant? Such a box is easy of construction, and not only that, but it could be fixed at the bottom of the steps, or elsewhere in the area, so that the pressure of the dustman's foot would cause it to rise to the pavement level, and so save needless trouble and useless exposure.

The dust collected in London is first of all screened, and then *picked over* by men, women, and children. The finer screenings,

breeze, is used by the brickmaker in tempering his clay, and the hes and coal waste is furthermore utilized at the brick kilns. The ıst pickings, or *hard core*, is used in the formation of roads; and it rms a curious spectacle for the proverbial countryman to see a ꞩw road in London whilst in process of making,—reminiscences of t. Giles's and St. James's, of Ginx and Lord Bantam, of the lady's ıbinet and the washerwoman's cupboard, lie there, all in loving ɔntiguity. As for what is called the *soft core*, the vegetable and nimal refuse, it is either burnt in the dust-sifting yards or barged way into the country.

It would hardly be credited that, to collect the dust of one London ırish—St. Pancras, for example, a yearly outlay of £6,000 is reıired. About 25,000 loads are, however, removed annually from e houses in that parish, and the breeze and ashes, at the rate of ılf a chaldron to the 1,000 of bricks, are equal to the production 50,000,000 of the latter. This is, however, brickmaking at the ɩpense of the householder and at the express invitation of the ıriftless housemaid, who will not sift her ashes. Were any of the ɔwer cinder boxes adopted, the saving in housekeeping expenses ould be considerable. There would also be less to cart away. iven an improved state of things in this respect, and a reduction in ɩh absorbents, the smell of the dust bin would necessitate the adopıon of a disinfectant. At all events, whether we should go on to raste that bricks might more abound, is a question that admits of nly one answer.

CHAPTER IX.

DISINFECTION AND DISINFECTANTS.

THERE are certain rules to be promulgated respecting the protection of human life from contagion, or from the injurious effects of decomposing organic matters, which may be gleaned from the experience of ages, and which as yet have never been laid down with sufficient clearness.

A writer in a medical journal, the other day, pointed out, from the Odessey of Homer, the great solicitude of Ulysses for the purification of his house with sulphur, and the history of purgation could go still further back, and bring to light many other interesting memorabilia. This, however, hardly comes within the scope of these short papers, neither does as I said before, any attempt to explain the cause of disease, for it would only be a repetition of wise things said before. Happily, too, the grim dwellers of the threshold are now watched with eye of lynx and nerve of steel, and their newer thrusts at poor mankind met or parried. Names like those of Drs. Parkes and Sanderson, in this respect, are fast becoming household words. For the purposes of this chapter, however, I cannot forbear from condensing the remarks of Dr. Angus Smith, with respect to disease generally. According to this authority, the classes of disease may be caused—firstly, by gases easily diffused in air, such as carbonic acid, nitrogen, marsh gas, and others; secondly, by vapours falling in cold air and taken up in fogs, volatile bodies in fact, that concentrate in cool temperatures, and not to be classed with gases; thirdly, by putrid or decomposing substances, that include, with the hurtful gases named under the first head, many organic forms which, transferred to a suitable soil, are capable of working havoc with life and health; and, fourthly, by those more organized bodies in various stages and ferments that have a definite existence, and that multiply the diseases to which they are most allied, whenever they meet with *suitable fields for* propagation.

Disinfection is practised by fits and starts. With us it has been inly a summer practice, when our nostrils encounter the smell of ensive matters. Contagion seizes a house, or a town, and for a time sanitary inspectors, and the awakened people themselves, disbute even the most noxious disinfectants without system, and with inevitable result of expending the most money with the least ssible good result. The destruction of valuable property, a sensess panic, and a relapse into the indulgence of time-honoured abuses, e the common results of outbreaks of typhus or typhoid fevers, of all pox, cholera, or any other of the many diseases by which we punished for grave derelictions of duty. We cannot neglect with punity the maintenance of personal and household cleanliness— tilation, and an abundant supply of pure water. Soap and soda the simplest expedients at our disposal for cleansing purposes. perience teaches us that ancient cities, and even modern human ellings, are admirably suited to act as reservoirs of contagion, and constantly polluted by the excreta of the healthy as well as of the c. We have, therefore, been compelled to resort to disinfection. t such has been our short-sightedness in the matter, that the emyment of any agent to destroy infection is too often evaded, and has ially been rendered most distasteful and even painful. A nauseous ting has been put upon this very simple pill. A poor woman is t to the oilshop for a little chloride of lime—a foul room is thereby idered unbearable, the place has to be thrown open, disinfection is t attained, and the *maximum* of discomfort is attended with a *nimum* of benefit.

Some medical men are, I fear, blameable for not estimating with eater precision the real benefits derived from the use of volatile sinfectants. They are all irritating and of bad odour, and a popur belief has arisen that unless they are foul and caustic they can no good service. A distinguished chemist, Mr. J. A. Wanklyn, is very recently shown that the constitution of a poisoned atmohere cannot be modified even in a small dwelling by an expenditure material that would be certainly beyond the means of a wealthy erson. To diminish the evils of a malign atmosphere, he says,— ventilate," and whilst admitting the correctness of this, I shall ttempt to show that means may be employed for fixing the poisonous articles floating in a fever chamber without rendering the air of

that chamber irrespirable, or without killing a patient by draughts of cold air.

Disinfectants are employed as deodorizers and as contagion destroyers. Such agents as carbolic acid prevent the decomposition of organic matter, and, therefore, favour a state of atmospheric purity; but carbolic acid is not a deodorizer. It makes, but it does not absorb or destroy, fœtid vapours: and it is for this reason that M. Lemaire and others have recommended the use of carbolic acid in conjunction with sulphate of zinc, salts of iron, chloride of lime, and so on.

There is indisputable similarity between the working of putrid germs and of the seeds of the most virulent plagues. Fevers were classed of old as putrid diseases, and anyone who has witnessed the prompt decomposition and the foul emanations of fever-stricken beings, whether human or brute, can readily understand that it was no very indiarubber-like stretch of the imagination that led our forefathers to confound contagion with putrescence.

It is, however, necessary to learn, that in practising disinfection we have to neutralize the products, or check the decay, of healthy matter separated from living plants or animals, and that we have likewise to destroy specific elements of contagion—elements which differ in the various maladies that are known to be transmissable from the sick to the healthy. In order to illustrate this, let us take the case of sewage. The excreta of healthy human beings decompose, and the sewer gases belong to the class of irrespirable gases which cannot be absorbed into the system without producing serious ill effects, and even symptoms such as characterize a putrid fever—vomiting, faintness followed by prolonged stupor, fœtid diarrhœa, and even death. The results are apparently undistinguishable from typhus fever. The line of demarcation between a malignant fever produced under such circumstances and fevers due to a specific virus has not yet been satisfactorily established.

The foregoing symptoms result also from decomposing matters passing into the blood by other than the lungs, and whole hecatombs of slain through the instrumentality of hospital gangrene, pyæmia, puerperal fever, and allied diseases, testify to the great dangers arising from the diffusion of solid or fluid matters in a state of decomposition. In dealing with the excreta of the sick, it is not the volatile elements and simple gases that we have to fear, but the materials

hat adhere to anything and everything on and around the sick, and f ever we allow them to pass from the sick room it is quite impos-ible to control them. If we even let them pass in any quantity from oom to room or house to house in atmospheric currents, we cannot race them until they have victimized fresh subjects susceptible to heir pernicious influences.

For our purpose it may be accepted as proved that successful dis-infection must aim at preventing decomposition in simple putrescible matters, or must aim at attacking fever germs as soon as discharged by the patient. It is desirable that a disinfectant should be an ntiseptic—viz., an agent that arrests chemical change in animal or egetable matters, and it must be a deodorizer, or capable of fixing he most noxious gases evolved. It has been erroneously believed hat sulphuretted hydrogen is the principal deleterious gas which isinfectants have to encounter—the worst kind of vermin to ferret ut. Professor Way, however, asserts that the gaseous elements that re usually foul smelling and hurtful are ammoniacal.

The best disinfectant to deal with sulphuretted hydrogen, such as s evolved in the emptying of a foul ashpit, would be salts of iron or hloride of zinc. Salts of iron and copper are antiseptics and very ctive deodorizers, and would have been used even more extensively han they have been, had they been harmless. But the iron salts tain all they come into contact with, and copper salts are injurious o life. Zinc salts are also inimical in this latter way. A disinfectant, o be available in the homes I am endeavouring to depict, must neces-sarily be harmless, and until quite recently it was not easy to find such an agent. The alkaline permanganates have been extolled as disinfectants. They are in many instances admirable deodorizers, but the fact that permanganates are sparingly soluble in water render their employment difficult, except in dealing with small accu-mulations of putrid matter.

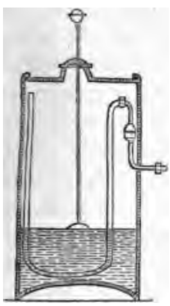
There is one volatile deodorizer and disinfectant that has been re-commended very strongly in some cases by Dr. B. W. Richardson and Mr. T. Spencer Wells, and that is iodine. In some virulent diseases attended with fœtid discharges, a little iodine placed in a box, with a little muslin to confine it, is sufficient to render the room tolerable to the attendants upon the sick. For similar purposes, peat, sea-weed, wood, or animal charcoal have been recommended, owing to the

avidity with which they condense the gases of decomposition within their pores. For some years, Professor Gamgee has used charcoal charged with sulphurous acid as an active antiseptic, and he now suggests the use of charcoal mixed with chloride of aluminum, or, as he popularly calls it, chloralum. The sulphurous acid renders air irrespirable, but chloralum, which is a deliquescent chloride of aluminum, attracts and neutralizes the noxious elements of a poisoned atmosphere.

Having attempted to show that disinfection must be an everyday practice in the household, and that disinfectants must necessarily be harmless antiseptic deodorizers, it is not difficult to establish a code of rules of almost universal application. There is a caution that should be given at all times to a householder:—Servants cannot be expected to understand the use of disinfectants any more than they can be trusted to carry out a system of ventilation. Disinfection and ventilation, therefore, should, to a large extent, be automatic processes, and, happily, such things are to be found.

A fusion of the two processes of disinfection and ventilation has been tried of late in the following manner:—The space occupied by a top pane of glass is fitted up with a piece of metal which slants from the bottom upwards, and the top is rounded in shape and perforated. Inside this wedge-shaped ventilator are two shelves, pierced with holes, the top one being made to carry a box of charcoal and the bottom one a piece of sponge. By this double contrivance the inventor and patentee, Dr. Howard, of St. John's, Canada, claims not only to absorb the watery vapour of the incoming air by the sponge, and disinfect any foul air that may seek entrance by means of the charcoal, but also to warm the cold air by the amount of friction it has to undergo in its ingress through the body of a ventilator which is already somewhat heated by the warmth of the room. If the wind blows too strongly upon the outside mouth of the ventilator Dr. Howard proposes a sliding valve to work up and down inside the pane occupied by the apparatus. I cannot but regard such a contrivance as a clumsy one. It may be said to stand in the same relationship to either perfect ventilation or perfect disinfection that spurious freemasonry does to what is called craft masonry, or certain litharges to good white lead. There is no necessity, either, to filter *the air* of a room in such a manner.

There can, however, be a strong case made out why the water-closet pans of a house should be disinfected, and I am able to point out an apparatus which fulfils every requirement for that purpose. It is exhibited at Fig. 153, in section, and is known as Brown's patent self-acting disinfector. The object is to deliver at every upheaval of the handle a certain portion of a fluid disinfectant; viz., chloralum. The construction is the essence of simplicity. In a metal, glass, or earthenware vessel holding a gallon of disinfecting fluid a metal syphon is fixed, and the bottom is coiled and has a small inlet, by which means the syphon fills itself. When the closet handle is raised, the water rushing down the supply pipe to flush the basin causes a vacuum in the disinfecting syphon, and its contents are blended with the water. By this means a portion of the deodorizing fluid is retained in the trap or basin where it has no sinecure of work to perform. The syphon refills in a few seconds, and as only a *certain* quantity is discharged, a pint of disinfecting fluid, costing one shilling, mixed with sufficient water to make up the gallon, will serve about 140 distinct actions of the closet. The cost of the apparatus is about eighteen shillings, and it can be fixed in an hour to a water-closet of any pattern. The vessel containing the fluid is usually fixed upon a bracket in a corner above the seat. This kind of apparatus can be fixed to a tap in the stable, or anywhere else, and water containing a percentage of the medicated fluid drawn off into buckets, or run off into the pavement drains.



153.

Such disinfectors are not new, but the above is the simplest. A patent automatic apparatus for a similar purpose was introduced some little time ago by Mr. Spencer. It is also worked by the handle of the closet, and fixed on the wall above the seat, but it is dependent upon a complicated action of wires and cranks, and its cost is, moreover, thirty shillings. Similar contrivances are sold adaptable to the earth closets now in use. Whether it be true or not that the partizans of the earth closet first drew attention to the disinfection of the excreta, I do not know, but at all events they were not far behind. I have already given an example of these as applied to the earth or ash closet. As a matter of course they are chiefly powdered

disinfectants. Mr. Bannehr, in his improved ash closet, uses a simple carbonaceous powder, chiefly as an absorbing medium.

Nothing could be more wearisome than wading through the history of disinfectants, and yet an occasional smile would be sure to light up the way. Who would propose to burn incense to the god of Stinks at various times throughout the day, in the shape of patent pastiles, composed chiefly of charcoal, sulphur, and nitrate of potass? Or who could be brought to look, Hindoo fashion, on his patrimonial open drain or sewer as a River Ganges, and with religious punctuality set adrift upon the water there a sacred vessel which would admit a certain portion of such water, and also containing a phosphuret which would decompose in contact with the water, the gas and flame thus evolved being understood to neutralize the evaporating poison of Siva, the destroyer? And yet men have paid for leave to rivet such absurdities upon us, and the cry is "Still they come." Since the time of M. Legras, who, in 1849, claimed to discover, and patented, not less than twelve disinfectants (three liquids and nine powders), what have householders not had to endure?

Apart from the many simpler disinfectants, such as earth, ashes, charcoal, peat, salt, sulphur, gypsum, alum, vinegar, and tar-water, &c., suitable for the coarser purposes of a farm, the disinfectants for the house now in commerce may be reckoned on the fingers of one hand. I have already given a general indication of the action of each, and will only add, that these useful agents have now been brought to such a state of perfection, that the person who chooses to make up his own mixtures, puts himself in the position of an ague patient, who, ignoring the labours of chemistry, prefers the powdered Peruvian bark to the sulphate of quinine.

The disinfectant used in a household ought certainly to be a non-poisonous one. Fortunately, or unfortunately, there is not any choice, for the only one of this description is chloralum, now adopted by the Board of Trade. This is the popular name bestowed upon it by its inventor, Professor Gamgee. It contains 1,500 grains of hydrated chloride of aluminum to the pint, or about 75 grains to the ounce, and is sold in a fluid and solid state. Slightly diluted, the former will disinfect secretions in the utensils of a sick room; and exposed in a saucer in its concentrated form, I have found it to remove even the smell which is given off by a newly-painted room. In its

powdered state it may be sprinkled in cellars, larders, dust-bins, ash pits, stables, piggeries, poultry houses, and wherever a smell is continually arising. In the deodorization of sewage, whilst being pumped over the garden, one gallon of the fluid, or three pounds of the powder, will suffice for 150 gallons of sewage.

As regards the disinfection of clothing in the laundry, Mrs. Meredith, the patroness of the Discharged Female Prisoners' Aid Society, lately wrote to the *Standard* newspaper as under:—

"The articles taken in for the wash are fairly sprinkled with chloralum powder; they are then packed in sacks, in which they remain for about two hours, when they arrive at the washhouse. They are then unpacked, and shaken singly. After this they are put in a large tank, where a great quantity of water flows over and through them. In this way they rest for at least twelve hours. They are then wrung out, and undergo the ordinary process of washing. It is highly satisfactory to add that not the least deterioration of texture or colour results."

At the washhouses referred to by this lady, a great number of women are employed, and nothing but washing the clothing of the sick is carried on.

CHAPTER X.

UTILIZATION OF SEWAGE FILTRATION.

HAVING noticed the various systems of collecting the different *effete* matters, and pointed out the most worthy ones, a few lines as to their ultimate disposal may not be unwelcome to the reader. It is at all times preferable to follow things to their finalities, and fortunately the ulterior use of sewage will not require much word painting. Filtration, precipitation, and irrigation, may be said to comprise the different methods of utilization, and we will now see in what manner they are each carried out.

Filtration may be either a means taken to reach an end, or it may be the only thing desired. Simple filtration consists in separating the matters in suspension from the liquid portion of the sewage. The outfall of the sewer may lead to a series of filtering beds, or the solid matters may be seperated by subsidence in a tank fitted with perpendicular or other screens. In both cases the liquid overflow is allowed to run into the river. The solid matters, which turn dark in colour as exposure goes on, are then taken out of the filter or screening tank and mixed with the town ashes collected by the dustman, or with street sweepings. In this state it becomes manure, and is purchased by the agriculturists of the neighbourhood. The fluid portion, as we have seen, escapes into the rivers and brooks, and this frequently gives rise to costly litigation. No doubt exists as to the great quantity of animal and vegetable matters still held in solution by the escaped water, and its liability to putrefaction. If allowed to settle again, freshly suspended matter becomes evident, accompanied with turbidity and smell. This is pointed out by Professor Way, and he has furthermore shown that the effluent water is still charged with gases produced by the decay of the animal and vegetable refuse, the soluble mineral compounds of the sewage being of course also present. Sometimes this overflow water from the filters is, however,

ıade useful, and even after it has escaped into the brook the waters f such rivulet are used in irrigating the meadows lower down the ;ream. At other times the water is pumped up to the top of an ljoining field, and a rude kind of irrigation carried out. This kind f filtering, however, must be accounted as mere straining. Still it ; recommendable as a primary process in all cases of irrigation, or whilst keeping back from the ground the thousand and one sus-ended matters which can in no way benefit a farm, and which only mpede the flow in the carriers, it does not sensibly impoverish the ewage.

A stream of sewage may contain all kinds of animal and vegetable ıatters, and that too in all sizes, crude and manufactured. A wreath f flowers or a currant bush, a chignon or a dead dog, in fact anything ıat will swim, are every day noticeable at some outfalls. Many oating matters even pass through and over some kinds of tanks, or re retained there and clog their action. The most efficient con-ivance for intercepting these objects at the sewer outlet is Mr. aldwin Latham's Extractor, which may be shortly described as a ırge wheel divided into compartments actuated by a turbine,—ıe former furnished with an Archimedean screw, which receives the ›lid matter from the wheel, passes it on to another screw, and so on › waggons in waiting.

Mr. Sweetland, of Hendon, has lately made some experiments in he direction of filtering sewage, and he believes that the effluent vater might be rendered fit to mingle with that of brooks, and a 'aluable manure moreover formed by the filtration of sewage n air tight tanks, the water being forced downwards through suc-essive trays, each laden with some porous material. A patent nethod of filtration of sewage through tanks of ashes and vegetable harcoal has lately been brought out by Messrs. Weare and Co., at Stoke-upon-Trent. By this process the suspended excretal matter is satisfactorily arrested. The fluid which escapes from the top filter is then made to pass through three other tanks with ashes of graduating fineness, and the effluent water is said to be non-putrescent, and to satisfy the Government requirements. The charcoal and cinders in this car-bon-filtration process, when quite saturated, are dried in the sun and re-used. The solids are mixed with phospate of lime and soot after being ground, and this is sold as phospho-carbon-manure.

Had it even been previously unknown, the present outcry as to the sanitary state of New Brompton would prove that some of the water pumped from the shallow wells in London is simply filtered sewage. This establishes the fact that sewage can be filtered. Intermittent downward filtration through chalk or sand appears to be the most suited for the purification of sewage. This purification is the result of oxidation, but in order to be effectual, there must be a regular aeration of the filtering material. There is no question that this kind of filtration is superior to upward filtration. A serious objection to its use, however, is that it is non-productive, that the sewage is not utilized, and that it is merely a means of producing purer effluent water. It is, however, urged of late that the sewage of 3,000 individuals can be filtered of its impurities through one acre of land, and that edible vegetables can be grown on the filter at the same time. But fears have been expressed that this would be too much for the land, and that its pores would choke up. Narrowed down into a small compass, an efficient downward filtration through a few feet of soil or cinders, or some porous medium, will effectually cleanse the drainage water of a town, but it is to be recommended only where irrigation is found impossible. By this kind of filtration all the valuable constituents held in solution escape in the effluent water, and are lost to agriculture.

PRECIPITATION.

Having dealt shortly with the filtration of sewage, and pointed out its wastefulness, we approach the subject of the precipitation of sewage. This means the treatment of the sewage with different chemical re-agents, whereby a few or more of the useful constituents are deposited. Sometimes the chief object in view is the purification of the water contained in the sewage, and this is especially sought after when the effluent water must necessarily escape into a contiguous river; at other times, the chief object is the manufacture of a saleable manure, and this can be prosecuted when, for instance, the effluent water can be led into the sea, or in cases where the river is too vast to feel the pollution. It must be borne in mind that it is not sought to manufacture drinking water out of the supernatant fluid of the precipitation tanks, but only to come up as near as possible to the

commandments recommended to be enforced upon all sewerage ıanies by the Rivers Pollution Commissioners in 1868.

ındreds of systems of precipitation have been tried on a small in the laboratory, and scores have been carried out very extenγ indeed. Each country in Europe may be said to be interested very one of these experiments, large or small. The chemical ıry of any civilized nation bristles with propositions, more or less , as to this method of satisfying the question of the disposal ewage, which surely must have been the veritable query proıded by the ancient Sphynx. Some of the precipitating inients tried are simple, some costly, some are even imported from ıany because they can be purchased there cheaper than in our country. The chief value of some of the produced manures may id to be owing to the expensive materials used—in other words, ıost valuable matter precipitated was that which had been added e liquid sewage.

me of the processes of precipitation obtained a very large patronand joint-stock companies were formed to work them, which still per more or less; others which bade most fair at first were finally ıdoned as much worse than merely non-remunerative. Some few still carried out as a means of purifying the sewage water to it of its being turned into the streams and rivers, though they worked at a loss. The manures produced by several of the ımes are considered tolerably satisfactory, considering the valuable s which escape in the water; others disappointed the shareholders ratepayers in this way, and it has occurred before now that the ners around preferred the commonest raw manures to the patent s, which were to approach in excellence the guanos of Ichaboe and ıncha or Augamos. Sometimes the manipulations were attended an intolerable stench, which were only deodorized by an injunction m the superior courts of law. As for the water which ran off after st of these exploitations the clarification was incomplete always, the decomposition simply delayed.

The chemical and other materials used in the various precipitation ocesses are very numerous. For instance, lime was tried at Leister and Blackburn, and this material, mixed with chloride of iron, ıs tried at Northampton, and with perchloride of iron at Croydon. ille's method, now in use at Wimbledon, is in like manner a mixture

of lime, tar, and chloride of magnesium. Lime has also been mixed by Mr. Holden with sulphate of iron and coaldust for the same purpose. Mr. Jones and Lieut.-Colonel Scott, both of Ealing, also made use of lime, the former mixed it with 20 per cent. of petroleum or acid tar, and the latter supplemented a separate lime treatment by one in which several metallic salts played a part.

At Cheltenham and Stroud Mr. Bird's process has been tried, which is an addition to the sewage matter of crude sulphate of alumina. To this Mr. Stothert adds sulphate of zinc and charcoal. Salts of zinc and manganese have also been experimented upon, so have the carbolates of lime and magnesia, and the sulphates and superphosphates of magnesia on Mr. Blyth's specification. Hydrochloric acid, sulphite of iron and salt had before-time been tried and found wanting. I have already, when speaking of ashpits, instanced a few methods of dealing with feculent matter, and numerous others can be gleaned from publications which treat upon such matters. I will add, however, what may astonish some readers—upwards of fifty English patents were taken out, in a more or less complete manner, between 1857 and 1871. This is quite sufficient to innoculate any reader, who had previously slighted the question, with an idea of the vastness of the subject.

The system of precipitation now most in use is the alum, blood, and clay, or the ABC process—the patent of Mr. Sillar. It has been carried out at Leamington and Hastings. The newest system is the phosphate of alumina process, the patent of Messrs. Forbes and Price, and is being tried at Tottenham. It is not my intention to compare any of the many systems, because such a comparison would require a work to itself. The reader must consult the treatise of Dr. Corfield, and especially the Reports of the Sewage of Towns Commissions, the Reports of the Rivers Pollution Commission, and the various reports of the Medical Officer of the Privy Council. It would be useful also to consult the various Reports upon the Utilization of Sewage published by the Boards of Health of various districts. The reader by that time would be doubtless inclined to look upon the chemical treatment of sewage as a delusion, or at the most a transitionary arrangement.

IRRIGATION.

Irrigation as applied to sewage means the application of liquid

e to the land with the view of intercepting the fertilizing connts, and cleansing the water of such sewage. It is admitted on nds that sewage water can never be rendered fit for culinary ses, but the earth, if sufficient time is afforded it, will so oxidize lter it that the effluent water will be seen eventually to escape nost a pure condition.

e proper application of sewage is to run it over the surface of round, and not to apply it by means of underground pipes. The of the plants absorb the sewage as eagerly as do the majority ils. The best proof of this is instanced by Professor Corfield, ie case of the Figgate Whins, near Edinburgh. What ind could not absorb the grass roots did, and enormous crops he result. In such sandy farms there is seldom, if ever, any nt water, but it can be discovered by digging, and when so laid it has been found comparatively pure. It has been proposed to the peat bogs with abundance of liquid sewage, and experis made in this direction have shown excellent results. The difficulty of course with the Irish bogs would be to convey the ge to the bogs—but this could be done very well in peat tracts hose of the Marquis of Downshire, beyond the Chair of Kildare, aking use of the Dublin canals, and constructing tank-shaped s. The reader, in whatever part of the country he may be, if anxious to inspect the *modus operandi* of a sewage farm—will ably soon not have far to go, for such farms are fast multiplying. London resident can inspect meadows irrigated in this way at rdon, Barking, and Romford. The inhabitants of the Midland ities, &c., can satisfy their curiosity at Malvern, Warwick, bury, Cheltenham, and Oxford. The Welsh, Scotch, and Irish ners, are also fast becoming enamoured of the system—and even man landowners are following the Englishman's example.

There are two systems of applying the sewage to the land: one is distribution of the material by the aid of the hose, much the fire-engineman delivers his water. In this case the sewage is iveyed to the fields in underground pipes. As stated before, this is t an approved method, as it is the roots and not the leaves of the ants which require drenching. It is claimed that by this system ery portion of the land can be got under control, but I believe it is st becoming obsolete. The other method of delivering the sewage

is by open channels upon the surface of the ground. Such open exposure does not appear to entail any appreciable loss of the valuable volatile constituents of the sewage. The irrigating fluid is sometimes carried across the field at various levels and allowed to spread naturally downwards, or pieces are set apart, and the sewage carrier is carried along the centre and emptied on each side. These are respectively called the "pane and gutter" and "ridge and furrow" plans, and the latter is generally deemed the most successful. I gave an illustration of the best kind of "carriers" and sluice valves at page 27. The condition of the sewage led upon the land depends of course greatly upon the presence or absence of the storm and subsoil waters. To keep these out of the sewage altogether would necessitate two separate systems of drainage. This would be very expensive, and the cost would be enhanced by the fittings necessary to enable the sewage drains to be flushed by the surface and other waters. The infusion of these waters would also be absolutely necessary in dry seasons, when the sewage would be too strong and need such dilution. During the driest part of the season last year the escaped waters had frequently to be caught and repumped into the tank, in order to cause the mass to flow in the carriers. It is not, moreover, uncommon to find the sewage irrigation carried out in the middle of winter, so as to prepare for a precocious spring crop.

Every great scheme has its vexed questions, just as every old country side has its particular ghost, and sewage irrigation has also afforded its quota of controversy. One point in dispute is the necessity of sub-drainage on irrigated lands. Mr. Bailey Denton holds that under drainage is an essential to all proper irrigation, and Mr. Baldwin Latham is of opinion that supersaturation is impossible, at least that sub-drainage is only necessary in dense cold flat soils where there is no natural circulation. Another debateable matter is the probabilty or otherwise of engendering parasitic diseases by the wholesale distribution of sewage upon grass and vegetable producing lands. Those who are curious will find some original papers by Dr. Cobbold, the celebrated helminthologist in the "Veterinarian." These and other contributions from the same pen caused at one time a considerable sensation, and a believer in the representative philosophy of Emerson might fairly have said that at last the time of Entozoa *had come,* and with it the man. The question is still occasionally *seriously debated.*

e crops grown upon the various sewage farms are of great ty. Professor Corfield mentions a catalogue of thirty-eight ent vegetables which have been raised upon the Lodge Farm at ing. Various cereals head the list, then follow in due order es, cabbages, root crops, potatos, salads, currants, and berries l kinds. The crop mostly grown is the Italian rye-grass, h is said to be more suitable for the elaboration of milk in the than any other. Mr. Hope considers this grass to be the staple ge crop. He considers that it will produce, under proper agement, and sown in August, over ninety tons per acre in one n, in ten different crops. One would consider that this is sation with a vengeance, and that Victor Hugo, (when he wrote amous Paris-sewage chapter in "*Les Miserables*," which the l, perhaps, owes to the before-published treatise of Parent atelet,) never dreamed of such wholesale reconversion.

is an interesting fact, and Dr. Buchanan vouches for it, that the a rate is notably reduced in places where pipe sewers have been –phthisis, especially, disappearing with an improved drainage. satisfaction is further enhanced when we read, in various ical reports, that irrigation, as practised above, in no way what- encourages typhus, enteric fever, dysentery, or cholera, even in emic seasons. Such a condition of things ought to make us kful, for it is evident that the water-closet and not the earth- et system will finally prevail over the land.

CHAPTER XI.

SMOKE DRAINAGE, ROOF GARDENS, AND SMOKE SEWERAGE.

ONE of the best proclaimed nuisances of modern days is the smoke nuisance—and many means have been tried to avert it. But a fear has been expressed that if we had a more perfect combustion than we have, if no smoke, or unconsumed carbon were to escape from our chimneys, we should be worse off than ever, unless we resorted to the use of an enormous chimney, which would take up the carbonic and sulphurous acid gases to a height where they would be diluted by the "viewless winds" as fast as they left the summit. The carbon, the soot, the smoke would, in other words, prove less noxious than the poisonous gases which would in that case descend from our chimneys, and deteriorate our immediate atmosphere. And there is little doubt that there is good sense displayed in the expression of such a fear. Hence it is that without exception all who have advocated the idea of smoke drainage, specify the use of a lofty shaft. In the first portion of this chapter I propose to confine myself to a short examination of the removal of smoke in flues or drains apportioned to smoke only; the idea of passing our smoke into the sewers I will allude to at the close of the paper.

The first gentleman who recommended the adoption of smoke drainage was, I believe, Mr. Spencer Wells, in August, 1853. He was then editor of the *Medical Times and Gazette*, and his words were repeated as late as March, 1863, in the *Social Science Review*. He says:—

"If they (the factories) do not produce *the* great cloud of smoke, they certainly produce *a* great cloud, as any one may convince himself. By an improved construction of fireplaces in private houses, the present wasteful consumption of fuel and unnecessary production of smoke may be diminished—by at least the half. We do not despair of seeing London freed from this—its inhabitants breathing as pure and clear an air as those of Paris, Berlin, or Vienna; and its buildings, cleansed from their present funereal coating, standing forth in all the unsullied beauty of their architecture.

"In this case a new feature would be added to the architecture, and we should then see a number of beautiful structures, not unlike miniature representations of the gigantic aqueducts of the ancient Romans, replacing our present unsightly

chimneys, and carrying all the smoke through closed conduits to centra furnaces where it would be in a great measure consumed, and its remaining portions discharged at a height too great to be injurious or unsightly. A small smoke rate, giving us pure air, would surely be as cheerfully borne as a sewer rate, which only purifies our houses by polluting our river."

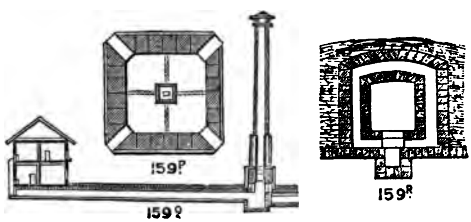
The reader will find a series of excellent papers upon the evil effects of smoke upon our health by Drs. Angus Smith, Calvert, and Mr. Spence, in the volume of the *Chemical News* for the year 1866.

Mr. B. W. Gibsone has also for some time persistently urged the principle of Smoke drainage, and amongst its advantages he enumerates:—

"Absence of smoke in a city atmosphere—Diminution of cost in construction of various chimney stacks—Absence of architectural disfigurements, such as zinc cowls and red cylindric pots—Saving of fuel by total consumption of the smoke in the grate, the fire burning downwards instead of upwards—Greater ease in cleansing the flu from soot, and in the removal of ashes—Steadiness and irreversibility of air-draugh and power of thoroughly ventilating a room, even when unfurnished with a fire."

Some of his conclusions are not, however, very clearly put.

The theory of the removal of smoke on the smoke drainage principle, is very simply illustrated at Fig. 159*p*. Here is represented one of those



large squares which the socialist teacher, Mr. Owen, proposed at one time to build in Liverpool. The principle of such erections was even discussed by him and others in the Social Hall of that city. About a hundred houses were to be arranged in this form of a square, with a chimney shaft in the centre as drawn at Fig. 159*p*. The smoke from each side of the quadrangle was to be taken into the monster chimney by descending flues from each house, joining into an underground flue leading into the shaft, as seen at Fig. 159*q*. A section of the proposed underground flue, about 30 inches square, shewing the proposed double

walling and percolation trough below, is given at Fig. 159*r*. At the chimney base, a chamber was to be constructed—a regular furnace for the creation of a perfect draught, was joined to the shaft. To prevent diffusion of the heat, the first fifty feet of the chimney was to be built with hollow walls, as shewn. Mr. Cubitt and others afterwards took up the idea, and prepared similar schemes for building houses in blocks, and connecting them to the central shaft, by means of descending and underground flues; but I believe none were ever carried out. The idea was further elaborated of late in the columns of the *Times*, and is now more or less familiar to all.

Several objections have been raised, even fulminated, against the above scheme, but, I think, after an insufficient consideration of the question. The projectors of a new scheme have generally consumed more of the midnight oil than have their critics. The gravest objection raised, was in a late number of a building paper, viz., "that few men would be brave enough to take a house, the comfort of which depended on the constantly successful issue of combined action, over which he had no control." This must be conceded at once. But no wise partizan of the scheme would urge the indiscriminate connection of *all* fire-places to a drain of the kind, and unless the surroundings were in every way favourable.

It could only be worked well in districts originally laid out upon this principle, such as conceived by Messrs. Wells, Spence, Owen, Cubitt, and the other originators of the plan. Another objection was, that underground London, and other cities, are sufficiently crowded already with bricks and mortar. Many do not consider this a conclusively deterrent reason, and I am one of them. Some aver that it would interfere with the liberty of the subject, to make drainage compulsory. As for that, a present opponent of the plan may rest assured, that if it was found to answer, a coercive law would soon follow, but that no act of constraint will be passed until it is proved considerably more beneficial than the present system. A more worthy objection is the difficulty of getting rid of the soot in the drains. A fan or blower would be, for the most part, inoperative. But it is urged that as the combustion would be improved, there would be less soot; and what there was formed could be removed by the periodical introduction of scrapers, or such-like simple machinery.

The prevention of black smoke from our workshops occupied the

:ention of our manufacturers and chemists long before the passing the Smoke Act of 1854. During the past seventy years no less than) patents for smoke prevention have been taken out in England me. Some were for preventing this dense smoke by preparing the fuel th chemical substances. For instance, Mr. Holmes, in 1857, proposed e admixture of salts with the fuel to be burnt. In the following ar Messrs. Bergevin and Salva recommended the fuel to receive a *uche* of certain diluted preparations of manganese and nitrate of da combined with oxide of iron, and Mr. Blethyn anticipated the nsolidation of coal and pitch now so common in our patent fuel rks. A more elaborate treatment was that introduced by Mr. 'ery in 1862, who purified the coal by means of steam and chemical agents, which latter were progressively applied as the coal became ll heated.

The diffusion of smoke from the chimneys of manufactories was also empted to be cured by a nicer regulation of the supply of fuel, by :ing the coal in a hopper, and by injecting hot air into the fur- :es. In 1860 Mr. Birch conceived the idea of compelling the smoke repass through the fire. Messrs. Gallafeint and Pontifex explained it the principal causes of the consumption of smoke were the regular ;erstices provided in the burning material, and they suggested aerical or polygonal coal blocks pierced in some cases with holes. is ball theory had been recommended by Mr. Ducayla as far back 1853. A totally different cure was also sought by the distillation of e coal. Amongst the first proposals of this kind was that of Mr.)urne, in 1838, who constructed two retorts in the furnace and aptied them alternately into the fire. Mr. Leighton varied this by ie insertion of a coal-coking chamber at the back of the fire. Mr.)ssa, for his part, practised dry distillation before consumption, and)nveyed the evolved gases under the boiler, which they served to eat. As for another patentee, Mr. Hick, he advocated the division f the boiler into two parts behind the furnace, and the construc- ion of a walled-up gas-chamber between, where the smoke could be atisfactorily dealt with.

The injection of combustible gases was reckoned upon in the :eduction of the smoke nuisance. Mr. White's idea in 1849 was the introduction into the chimney-flues of gas obtained from the decom- position of water. During the years of debate upon the Smoke Act

12

Mr. M'Connel suggested that a jet of common gas should be lighted in the flues, and the smoke burnt in its upward voyage. Mr. Chibnall improved upon this by describing the coils of bent and perforated gas-tube which was to perform the wonder. The idea of ordinary gas was subsequently ignored, and jets of hydrogen gas substituted by Mr. Lancaster. Even the idea of gas altogether was scouted by Mr. Houston, who was for stopping the ascension of smoke by blowing a stream of fire upon the coals, and consuming the smoke in its very birth.

Partially satisfactory was the injection of air or steam into the flues or upon the fuel itself. Amongst the first plans which appealed to public favour was that of Mr. Ivison, who projected a stream of steam between the fire and the boiler, the heat decomposing the steam, and causing the liberated oxygen to unite with the carbon of the smoke. But the most complete system of treatment with steam was the one published in 1865 by Mr. Sicardo, who, instead of permitting the smoke to escape up the chimney, drove it, by an air-separating fan, into a twin pipe, the smaller and lower part of which conveyed the smokeless air to the chimney, the upper and larger one taking the smoke, &c., to a reservoir, from whence it was borne, with a quantity of exhaust steam, to the underside of the fire grate.

Other cures were sought with more or less success. The general arrangements of the different parts of the furnace were altered in nearly every known way. To give an ordinary instance, smoke-distributing pipes were made to perforate the bridge of the furnace, and these were heated to a red heat, the combustion of the smoke taking place in its passage through them. The smoke was also invited by Mr. Holt, in 1856, to a regular *contra-danse* on the floor of the furnace, its partners being represented by different sets of fire-bars, and the figures described being purposely circuitous. In some other schemes the volatile products of the furnaces were heated, and the smoke consumed in that fashion. Amongst such plans was that of Mr. Rydell, in 1861, who passed the smoke through a red-hot retort. As for the systems of curing smoke by regulating and distributing the supply of air, and mixing hot or cold air with the smoke, they number more than three hundred. In point of number, the plans broached for compelling the smoke to pass over or through incandescent fuel come next, such as, for instance, by making use of two

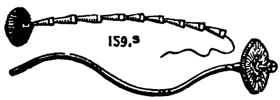
ımbined furnaces, and causing the smoke of the newly stoked one to ıter the other.

The above briefly represents the various groups of devices for dispensıg with the black smoke of the manufacturing chimneys. As for the ghter coloured and better consumed smoke given off by our household res, not less than 30 different modes of dealing with it have been uggested. There are also above 150 different kinds of domestic fireılaces in the Building market. Add to these, upwards of 50 methods f sweeping flues, and over 110 different patterns of chimney pots, and hese compilations will doubtless convince the reader that smoke as been considered from nearly every point of view, and that t all events, the lofty shaft and underground soot drain should now ı its turn have a national trial. If it prove a success, let all the eople cry *Eureka!* if a failure, let a final *Vale!* salute it; and let s take to other promising schemes—the heating of the factory ırnaces, steamboat boilers, and public buildings, by means of the apours of hydrocarbon liquids, and a still further prosecution of ıe advantages offered by the purer kinds of lighting gases. We may ı this way improve our atmosphere, as well as economise the contents f our fast emptying coalfields.

There is no doubt that an eclectic scheme of getting rid of the bulk ıf our dark smoke could be devised out of the many plans now ıxtant. Some of them act tolerably well even now, and would work etter if enforced, and the consequent improvement brought to bear upon them which always follows a demand for a particular thing. What a picture of blackness must have hung over towns like Manchester in the earlier part of this century? The condition of the London atmosphere must also have been abominable. Not a little remains yet to be done. How frequently do we notice that, for very cleanliness sake, even in the West-end of the Metropolis, a piece of finely-perforated zinc is made to act in lieu of an open ventilator? It is also a horrid scandal that, in order to keep out the "blacks and smuts," the artizan classes should be obliged to close the windows of their contracted rooms, and that disease should result from such imperfect ventilation. One can even notice in some streets the poor woman's single room made to do duty as a laundry, and the only window shut to ward off the dirty flakes of carbon. That such evils are even yet the rule in some towns is ably proved in the speech

delivered by Sir R. Peel, in his place in the House of Commons, on the 9th of March, 1866. It was on the very outskirts of patience that the first smoke-consuming furnace was built;—will it be on the threshold of wisdom that the pioneer smoke drainage shaft is erected?

Descending to the minutiæ of the smoke question, there can be no doubt that the oftener the present chimneys are swept the better. Too frequently the soot is allowed to accumulate until it holds together no longer. In cases where a contract cannot be made with a suitable sweep, or the monthly charge exceeds the means of the householder, why not sweep out the vents by home labour with the aid of such machines as are sketched at Fig. 159*s*? These represent the cheap contrivances for this purpose, sold by Mr. Black, of St. Andrew's Square, Edinburgh. The upper design illustrates a brush of whalebone, with a rope attached to the centre, on which wooden tubes are threaded like long beads. Each tube has a metal ring at the end, into which the other end is socketed. All that is needed is to push the brush up the chimney, and then tube after tube, until the top is reached, when a tug at the rope will dislodge the collected soot. In the more crooked flues, the Malacca canes screwed together, as shewn in the lower sketch, will be found effectual. Soot sheets, with telescopic rods for fitting into the fire-place, and sleeves for putting the canes through, and so enclosing the soot whilst sweeping, are sold by the same firm. One point is well worthy of attention in the construction of flues which climb an out-side wall, and that is the insertion of soot doors and frames, which will enable the chimneys to be swept from the outside, and save the inconvenience of taking up the carpets or covering the furniture in-side the room. The above contrivances will also serve for removing obstructions in drains.



THE ROOF GARDEN.

Mr. Charles Reade, in the *Pall Mall Gazette*, not long ago, published a protest against the present system of conical roofs, and an invitation to embrace what he terms the Rational Roof system. *This is merely* a flat roof, which will admit of perambulation over

and of utilization as a drying ground, &c. But, as Mr. Robinson inted out in *The Garden*, for December, 1871, Mr. Reade over-)ked the greatest of the advantages which a flat roof would offer, *viz.*, plendid site for a garden. Such a garden would necessarily be roofed er.

The case for the roof garden is admirably stated before the public, ho is to judge it, by Mr. Parsons, in the columns of the *American* |*griculturist*. I extract the following portion of the letter, which eals with the practical part of the question.

"The superficial area of nearly every good city house is more than twelve hundred uare feet. This would contain quite an orchard of fertile little fruit-trees. If one shes no flowers, but fruit only, he can have forced peaches and nectarines at a season ien he cannot buy them for less than a dollar each. But if it be desired to have the use filled with flowers through the winter, we cannot cultivate forced fruit. We ı, however, have flowers, stone fruit, and black Hamburg grapes in succession. If e house has been filled with flowering plants in the winter, and there is plenty of rd room, they can be taken out and arranged in groups in the yard as soon as all nger of frost is over. The house can then be filled with peaches, plums, and necta-ies in pots, which can be obtained of the nurserymen ready for fruiting, or prepared e previous year by the florist having charge of the house, and kept in the cellar ring the winter. These can remain in the house until the fruit has attained suf-ient size to be safe, when they also can be grouped in the yard, where they will grow, d ripen early and well. Their place in the house can then be supplied with grapes pots which have been retarded by being kept in a cool, dark place in the cellar, hese will then bear abundantly during the summer, and before the flowering plants quire to be taken in the ensuing autumn, will duly respond to the tiller in Black [amburgs and Muscats. Two pounds to each vine, or four hundred pounds of grapes, rould be a moderate estimate for the space mentioned."

Mr. Parsons proposes to lay upon the roof sufficient earth to form a ıatural garden, in contradistinction to a garden made up of congre-gated pots; but on this point I believe that he would meet with strenuous opposition even from those who accept the principle of the roof garden. A sufficiently pleasing *coup d'œil* could be manufactured with the aid of variegated vases, and boxes of enamelled tiles, filled with fruit trees; depending baskets with drooping vegetation, and wired columns covered with climbing flowers. Above all, the not altogether unfounded feeling of dampness which a layer of some feet of moist earth over a sleeping room would be sure to suggest, would by this means be avoided. Mr. Parsons also considers that if the doors of the house were kept open, the ascending waste heat of the house would serve to keep the roof garden house at a sufficiently high temperature. This might be so in parts of America, but with us it

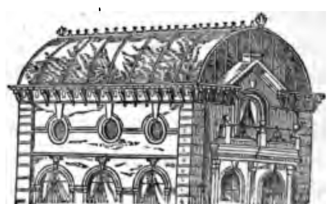
would be wise to furnish the house with hot water pipes. The water would be best heated in gas boilers, which would require no supply cistern, and merely the addition of a pint of water to the pipes weekly. The use of gas heating in the greenhouse has been much censured, but, in my opinion, unnecessarily so. At all events the gas boiler is the only one in every way suited for the roof garden. A correspondent of the *Gardeners' Magazine* for August 5th, 1871, writes as follows:

"To commence, procure a gas-stove (Wright's patent, of Birmingham, I have, price about £5); fix a tin funnel on the top, take it in a straight line through the top of the house, to carry off the gaseous air arising from the stove, and elbow at top of funnel to turn round when required in the direction of the wind. The heat can be regulated as desired, and the stove lighted or put out at once, without the delay that occurs in having to light and attend a fire. I have ascertained that a greenhouse thus heated for five years answered admirably, and, with little attention, kept all the plants last severe winter in splendid condition. I have this year built a house about thirty feet long, and heated it thus. The pipes run along the front from each end, and heat it most effectually, economically, and safely. I tried it during the cold dull days we had in this cold north-easterly district early this summer, and it diffused a fine moist heat. I may explain there are two small metal vases inserted in the top pipe at each end, for filling the pipes with water, and when thoroughly heated and full of water, a little steam arises, which acts beneficially on the plants."

But even without the aid of pipes, a heat commensurate with the wants of the vegetation could be ensured by the adoption of the George's Gas Calorigen mentioned on page 193.

A view of a roof constructed on the system mentioned by Mr. Parson's, is given at Fig. 159*t*. It is what he calls a Mansard roof,

159t

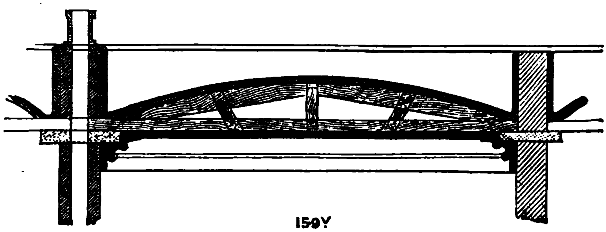


159v

and would suit the majority of cases very well. The construction of the roof-garden conservatory would not, necessarily, differ much from those built on the ground. The most elegant kind of roof for the purpose, would, perhaps, be the wood and glass roof introduced by Mr. Cranston, of Birmingham. An iron and glass construction, very suitable, would be that known as Ayre's Patent, manufactured by the *Imperishable Hothouse* Company, of Newark-upon-Trent. The

tings and stagings made by this firm would suit remarkably well, they are formed of cement which could take hold of the material the floor itself. The cheapest kind of roof-cover for narrow houses d cottages, would be the Paxton roof of Messrs. Hereman and orton, of London, but it would require to be supplemented with le walls of concrete, so as to give sufficient head room.

At Fig. 159*u*, I have drawn an imaginary roof-garden, constructed ith rafters having a parabolic curve. Hitherto, curved roofs have een chiefly made of iron; but I have lately seen a conservatory ailding, the curved roof bars of which were made of wood, bent by achinery. It was produced at about half the cost of an iron roof. ie bending roofs are more graceful than those formed of straight lines, d if wood could be used to such advantage as this experiment indited, the gain even in an æsthetic point of view, would be conlerable.

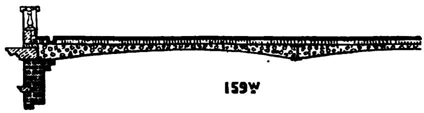


159V

I now propose to show how such a kind of roof could be constructed. ig. 159*v*, represents a section, copied from an Architectural journal, f the tile and cement roof adopted on the Redcliff Estate, South ensington. Here, wooden ribs, two feet apart, span between the arty walls, their ends resting upon stone corbels. On the upper surace of these ribs, boarding is laid down, and afterwards, two or three ourses of tiles, bedded in cement, the last course being rendered over rith cement and fine sand. It will be observed from the sketch, that he roof is not a flat one; but there is no reason why such a roof ould not be made with an amount of arching just sufficient to throw off the water.

The above mode of constructing, at the same time, a roof to the walls and a floor for the roof-garden, is not, however, in my opinion, the best suited for the purpose. I consider preferable, a roof formed on the Dennett arch principle, such as sketched

at Fig 159*w*. A description of the material which forms the arch is given at page 154. The Dennett roof would occupy less time in construction, and if found not quite so cheap, offers the advantage of being absolutely fireproof, which the tile and cement roof is not. When the concrete in the arch is considered sufficiently dry, it is covered over with the Pyrimont Seyssel, or some other first-class asphalte.



159W

From the foregoing, it may be seen that it is quite easy to pursue the idea of the roof-garden. The only thing wanting is the inclination to do so. But the innovation once begun, the system would continue by the sheer force of imitation, so common amongst islanders. And it would soon be discovered, that even in the neighbourhood of smoky cities, they could not only be made to afford an agreable retreat for the morning and the evening, and the first day, but also be made "to pay." The foregoing will convey some distinct idea of the roof garden scheme. Whether it will become a rule with us is very doubtful; whether exceptions should be made in its favour needs no argumentation. The introduction of these novel conservatories need not depend upon the adoption of the smoke drainage system, though undoubtedly the two would work admirably in unison. A noble opportunity of carrying out the smoke drainage theory was lost when the new Belgravian mansions on the estate of the Marquis of Westminster were given up to Chimney-dom, and the occasion was further misimproved when their roofs were handed over to French copyists. Seen from the Green Park, the roof gardens of Grosvenor Place might have been made to rival the hanging gardens of Old Babylon, as far as we understand the construction of the latter. Is it too late to try the experiment yet in the many terraces which are everywhere fringing our parks and heaths? The feasibility of such erections for better class mansions once proved, the boon would soon descend to the humbler residences; and if the majority of the latter could not afford to glory in a roof of crystal the artizan could use the flat roof as a promenade, or his wife use it as a laundry ground. I should not recommend waiting for the *smoke drainage theory* to be carried out. Who knows whether or not

main incentive to the underground flue and the tall shaft would e to be the growing desire for gardens on the housetops? At vents it would not be the first time that our nation was coerced benefit by the application of the argument indirect.

SMOKE SEWERAGE.

e chief elaborator of this scheme was Mr. Peter Spence, who pub- l, in 1857, a pamphlet upon the subject, entitled "Coal Smoke Sewage." I will quote his own words:—

vould combine this gaseous (smoke) sewerage in such a form with our town ge, as would bring all the liquid sewage into contact with the gases from our es and our house fires, the liquid sewage being kept, as now generally proposed, te from all surface drainage. The semi-liquid and fœtid mass being brought ontact with the sulphurous acid gas, (the result of our perfect combustion) would its putrefactive process arrested, and the foul emanations neutralized—all its nia converted into sulphite, and thus permanently fixed, and all the sulphuretted gen and other unwholesome gases decomposed.

hen concentrated, in this innoxious form, from various districts to a convenient it might with perfect safety be manufactured into manure more valuable than hest guano. All the gases from our coal combustion would have to be conveyed the same tunnels to centralizing conduits converging to a point, where an ise chimney, at least 600 ft. high, should be erected to discharge these gases into mosphere—the ascensive power being obtained either from the retained heat of gases, which would probably be found quite sufficient, or if not, artificial heat then be supplied to effect that object."

r. Gibsone, previously alluded to, has also lately advocated the ke sewerage, and in a letter to the *Times* in December last writes nder:—

Vhat substances do we use on a large scale as antiseptics and disinfectants? Sul- ous acid, carbon, and carbolic acid. That these three are the very ingredients nt in a most transportable form in coal-smoke is too evident to every eye and above ground.

What simpler ventilation for sewers than that each house should contribute its wasted hot-air in creating a draught down into them and out at a distant exit?

Meanwhile, as instalments of the future perfected good, we might gradually pt grates, in some measure at least, smoke-consuming—erect on rising grounds atively, lofty furnace chimneys exhausting our *cloacæ;* the heat would be utilized public washouses, and—connect the house flues with the sewers, and trap the nings to the latter."

I have been compelled to notice the above schemes because they ve become barnacled, so to speak, upon the simpler smoke ainage idea, and impede its progress. It is not to be dreamt of that

two separate systems of drains are everywhere to be constructed, the one for the sewerage and the other for the surface drainage. Mr. Gibsone suggests a division of cities and towns into districts, each having its own fire-system. Mr. Spence speaks of a chimney "at least 600 feet high," and this, he admits, will require 20,000,000 of bricks, and weigh 72,000 tons. It would also, he says, cost some £40,000, but "supersede say 500 chimneys in Manchester, costing, at an average, £500 each, or 250,000*l*."

The above scheme, as I have elsewhere pointed out, has lately dwarfed into a proposal to connect the house drains with the chimney flue. If this became general, what would result in the summer, when very few fires were needed? The whole question requires a thorough ventilation, and a complete reconsideration at the hands of its projectors.

CHAPTER XII.

THE WATER SUPPLY.

CISTERNS.

r we consider that nearly three-fourths of our living bulk is in
r water, a knowledge of the fact should be in itself sufficient to
e our best attention to the water supply of our dwellings. But
lately, the works of the large water companies were unsupplied
filter beds in order to intercept the more palpable impurities.
e present time to supply 500,000 houses in London, different
companies deliver nearly 110 millions of gallons per month.
unhealthy condition of the present retailed supply is, however,
enhanced by the treatment which it receives at the hands of the
mer, who stores it in unclean and uncovered cisterns, open to
ontaminations caused by bad smells from without, and to the
rities engendered by the water-closet valves within, which latter
l up like so many bag-pipes in the cistern. On the contrary, it
t to be borne in mind, that like milk, water speedily taints under
nfliction of a bad atmosphere. The consequence of all this
ect is, that the water speedily teems with low forms of life, and
kens with decomposing animal and vegetable matters—becomes, in
t, totally unfit for use.

he drinking water cistern should in no case be left exposed to the
rnal air, unless at the top of a properly constructed water tower,
perly roofed in and ventilated. In some places, as in London,
ere "smoky smuts prevail," the cistern will require a cover of some
d, with louvre like sides. As for the material of which the cisterns
ght to be made, I should recommend an enamelled slate cistern for
drinking and culinary water, and galvanized iron cisterns for the
h and closet services. Lead cisterns should never be used for
nking water, and as some soft waters slowly dissolve the lead, even
rain water should not be stored in leaden tanks.

There are several remarks to be made with reference to the cistern

itself, and as I have made it a point to give a quotation from some eminent authority when I have found anything apposite, I give them in Mr. Surgeon Jardine Murray's own words:—

"In a house of small size there is usually only one cistern, from which water is drawn for drinking, cooking, and supplying the closets. The pipe which supplies a water-closet is often made to open at the end furthest from the cistern; but in many instances it will be found that water is admitted into the pipe by a plug or valve raised by means of a wire. This is much the more objectionable plan; for in the interval between the times of use, the pipe, not being occupied with water, becomes filled with foul air which has ascended from the closet; and when the plug or valve within the cistern is raised water does not flow down the pipe till this stagnant air has bubbled up through the contents of the cistern. By either method there is risk of contamination of the water; and it seems unnecessary to insist that by the latter the pollution must be serious.

"In large houses, having two, three, or more cisterns, sanitary arrangements are equally overlooked, and the cistern on the kitchen floor, from which water is drawn for cooking and drinking purposes, too often supplies the servants' watercloset. It cannot be too strongly urged that in every house not supplied by 'constant service,' there should be one cistern specially set apart for drinking and cooking purposes. And with regard to its regulation three other points are to be carefully observed:—

"1.—The waste-pipe must not in any way communicate with the drains, else it may be the means of admitting foul air into the cistern, if not also into the house.

"2.—There must be a well-fitting cover, in order to protect the surface of the water from the organic and inorganic particles which are constantly floating in the atmosphere, more especially in that of the basement story.

"3.—At regular intervals the water must be entirely drawn off, so that the interior of the cistern may be thoroughy cleansed."

If the above be carefully attended to, and the water which is supplied be pure, the householder may rest quite easy as to his water supply.

WATER PIPES.

To the use of water conducted a long distance in leaden pipes, or stored in leaden cisterns, have been traced a great many evils, and the adoption of this metal in pipes and cisterns is now wisely tabooed. I question whether it will not become compulsory before long to use tinned pipes only. In the military hospital at Netley, not an ounce of lead is brought into contact with the water to be consumed. This entailed an expense of nearly £10,000. But, at whatever cost, the sanitary boon is great. In France and Germany there is a government law which compels the use of tin pipes, and nothing else, in the wine and beer establishments. That the use of lead pipes and cisterns seriously *interfere with* health, the following extracts will show.

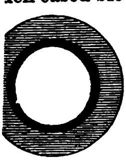
r. Muspratt says:

'he first stages of slow poisonings are very frequent, and well known to most of ;eneral medical practitioners in every large town, as well as in the rural districts. *source is almost invariably found to be the water employed for domestic purposes,* engthened use of which causes a depression of spirits, emaciation, and, finally, and paralysis. Several cases of this description have come under the notice of the r, wherein whole families were affected, and though the leaden indications in the ; were undiscerned—as their medical attendant in many of them appeared baffled ie continued and frequent complaints,—still carefully conducted analysis proved lead was the undermining agent."

r. B. W. Richardson also remarks:

'ontamination of water, both hard and soft, impure and pure, by lead is, in all ı of the kingdom, and under every variety of circumstances, the cause or sources ırious obscure diseases of man (and also, doubtless, of the lower animals), of the re especially of dyspepsia and colic. This proposition was abundantly proved by ; of minor diseases induced by lead contamination of various of the hard or impure ırs of London."

. cure for such poisoning could be found in the use of pottery ware es, but they are too brittle, and can only be made in short lengths. valnized iron pipes would also be an immense improvement upon l pipes; but these are apt to split under a high pressure, or during ;ty weather. It is satisfactory to know that there is a kind of pipe v in the market which meets every sanitary requirement: *viz.*, the len cased block-tin pipe, patented, in 1870, by Mr. Haines, and sold by Messrs. Walker, Campbell, and Co., of Liverpool, and Bloomsbury, in London. The inner ring of tin (see Fig. 159*e*) constitutes a distinct pipe in itself, and an uniform thickness of this metal is properly secured. The tin is not what is called tinned on the outer lead casing by pouring melted tin through the



159.e

pe, or by electro-plating it inside; for such made pipes offer no rmanent security against the removal of the tin by the friction of e water. The Haines' pipe consists of a separate ring of pure block-ı, surrounded by a lead case, and the junction of the two is so rfect that no ordinary contortion will rend them asunder. It is so believed to be unsusceptible to galvanic action. The great value this invention has already been testified to by Drs. Lankester, etheby, Muspratt, and others. I will now show the comparative st per yard of this and the common lead pipe mostly in use, the tter charged £20 per ton, which represents the average price.

COMMON LEAD PIPE.				LEAD ENCASED TIN PIPE, Of Equal Resistance to Pressure.			
Inside diam	Weight per Yard.	Cost per Yard.		Inside di·m	Average Length in Coils.	Price per Yard.	
Inches.	Lbs.	s.	d.	Inches.	Yards.	s.	d.
⅜	4	0	8½	⅜	70	0	8½
½	6	1	1	½	42	1	1
⅝	7	1	3	⅝	38	1	3
¾	10	1	9½	¾	30	1	9½
1	11	1	11½	1	36	1	11½
1¼	12½	2	2¾	1¼	34	2	2¾
1½	15½	2	9¼	1½	28	2	9¼
1¾	17	3	0½	1¾	26	3	0½

It will be seen by the above that it is sold at the same price as the lead pipe. The lengths of the coils in which the tinned pipe is manufactured will also be noticed.

The lead-encased tin pipe, however much an improvement upon the lead pipe, would be nearly useless if the effect of the inside tinning was to detract from the physical qualities of the pipe, or in other words, if it behaved badly during a heavy frost. It is pleasant to be able to record that this sanitary water pipe is even stronger than lead pipe in this respect; and to render this patent to anyone, I subjoin the results of some tests made by the eminent engineer, Mr. Kirkaldy:—

LEAD-ENCASED TIN PIPE.

Calibre of Pipe.	Weight per Yard.	Average Thickness of Pipe.	External Circumference.	Circumferential Extension at Bursting Pressure.	
inches.	lbs.	inches.	inches.	inches.	per cent.
½	3.034	·119	2.30	·36	15.6
¾	4.955	·137	3.20	·48	15.0
1	6.328	·133	4.06	·41	10.1
1¼	6.547	·114	4.70	·62	13.2

ORDINARY LEAD PIPE.

Calibre of Pipe.	Weight per Yard.	Average Thickness of Pipe.	External Circumference.	Circumferential Extension at Bursting Pressure.	
inches.	lbs.	inches.	inches.	inches.	per cent.
½	5 695	·183	2.75	·19	7.0
¾	8.218	·190	3.60	·44	12.2
1	11.312	205	4 45	·27	6.1
1¼	12.375	·186	5.15	·64	12.4

It will be easily seen that the percentage of extension under ırsting pressure in the above sized pipes (which are the sizes mostly use), are considerably in favour of the twin-metal pipe. The erage percentage was 13·5 for the latter, and 9·4 for the lead pipe.

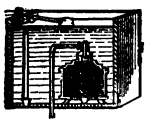
Cases will often occur in which waters require to be conveyed in ɔes of very large bore, and in such instances the lead-encased tin ɔe would be too expensive, if not quite impracticable. The kind of ɔe to be used with advantage here would be a cast-irrn pipe which s been subjected to the De Lavenant patent iron preserving process, ɩich is the coating of the surface of the metal, whilst cold, with a reous glaze, and then subjecting it to heat in an annealing furnace. '. Bazalgette subjected iron so treated to a red heat, and even then ɩnd the coating uninjured. I can also bear testimony to the great anliness of these pipes, and to their freedom from oxidation, having n them used under circumstances of peculiar difficulty. The water ws through them as through a glass pipe. There is no smell and no pping. The glaze can also be applied in all the colours of the nbow, if such fancy treatment is required. These pipes are alike ɔlicable to the conveyance of water, gas, or soil, and ought in all es to replace the common cast-iron conduits of large size from ıds, wells, and cisterns, whether above or below ground. In the e of buried pipes, the Lavenanting effectually preserves them. e enamelling process of this Company is also largely applied to all ts of culinary utensils. Cisterns are also supplied glazed inside in imilar way, and painted outside with silica paint.

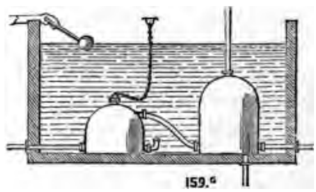
FILTERS.

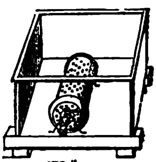
Γo rely upon a filter is not always safe, as all depends upon the ɑd which is used. Some of these have been known to yield ıter containing 100 grains of organic matter to the gallon, and s, too, after running the whole gauntlet of intercepting sub nces. They may also produce the brightest and most sparkling ter, and yet this water prove on examination to be fearfully ıtaminated. The sand, the sponge, the hair, and cotton ɔers are now seldom to be met with, except in the homes of the orer artizans, who are accustomed to point to these delusive articles home manufacture with evident pride. The above materials I

term delusive, because they serve the purpose for a very short time only, and either decompose, and thus add to the festering state of things in the cistern, or soon become hopelessly choked up. Peat and other vegetable charcoals were afterwards tried with temporary success. Charcoal obtained from the shale used in the manufacture of paraffin oil has also been mentioned as a suitable filter for waters unfit for use; and years ago, charcoal and glycerine were also considered as excellent materials for purifying unhealthy liquids. Only about twelve months ago, too, Mr. Lundy patented the application of the animal charcoal produced in the manufacture of prussiate of potass, as a decolourizer and deodorizer of water. Eventually, however, these all gave way, or are fast giving way, as filtering media, to bone black, or what is more frequently called animal charcoal.

That the best filters are useful, and even beyond praise, will be seen after a perusal of the article on filters by Professor Wanklyn, in the *British Medical Journal* for March, 1872.


159.f


159.g


159.h

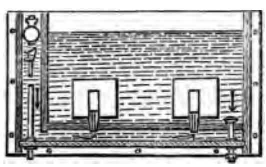
The first-class filters of the present day are not numerous, and are mostly used in the storing cisterns. The filter of the Water Purifying Company, Limited, of London, I illustrate at Fig. 159*f*, and in this cistern-filter the impurities in suspension remain outside the filter, those held in solution alone reach the interior of the filter. The water enters the purifying case from below and becomes freed from solid matters in its laboured ascension through the bone black to the mouth of the supply pipe.

A rather different kind of filter to the above is exhibited at Fig. 159*g*, and is known as Lipscombe's self-cleaning charcoal cistern-filter. The sketch represents a cistern furnished with a filter, and also with a pure water reservoir, the latter being the larger beehive vessel, situated on the right hand. The water enters the smaller or filtering vessel by the inlet at the middle of the cistern, and rises through a porous plate of stone and the superimposed body of charcoal,

until it reaches the descending pipe which conveys it to the reservoir. This latter is supplied at the top with an air-pipe for ventilating purposes, and horizontal depending pipes for the supply of the boiler, or the drinking caraffes. If the water is needed for the commoner household purposes, for cleaning or laundry use, a pipe which is connected with the bottom chamber of the filter vessel carries it directly to the scullery, before it has had an opportunity to rise through the beds of the filter.

In order to treat the subject as completely as the space will allow, I figure at 159*h* another kind of cistern filter, called the Patent Carbon Block Filter, manufactured by Atkins and Co., of London. These filters, of which there may be two or more in the one cistern, stand on legs at the bottom of the cistern, and are composed of porous blocks of charcoal set in a hollow cylinder, with moveable caps to facilitate the cleansing out. With this system no storeage of water is supposed to be needed, and the supply pipe is connected with the filter vessel direct.

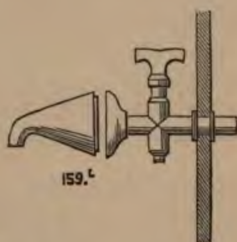
Another modern cistern filter is that of Mr. Finch, of the Holborn Sanitary Works, and it is drawn at Fig. 159*k*. This arrangement consists of an *exterior* tank, enclosing an inner partition, which extends across one end and over the bottom of the tank at a distance of 3 or 4 inches from the outside case. This vacant space, extending all over the bottom, forms a receptacle for any mud precipitating from the water, as it enters the tank, previous to its passage up through the two carbon filter blocks, which are shown in the middle of the tank. The water enters the tank by a ball-cock placed within the vacant space between the exterior and interior partition of tank. Any surplus water passes out through a stench trap placed at the head of the overflow pipe. This prevents the rise of smells from either drains or soil pipes, which invariably give a bad taste to the water. The outlet pipe, by which the water leaves the tank, is provided with a water-strainer, placed a few inches from the bottom of the inner partition. The strainer is formed of fine wire gauze placed over the pipe outlet, and prevents dirt, leaves, &c., getting into the pipes and causing a stoppage or leakage of the various valves or cocks.



159. K

It is not my intention to give any description of the numerous filters for domestic and other uses in which the water is poured by hand into the filter, but I cannot forbear noticing the magnetic purifying water filter sold by that Company, at their offices in Euston-square, London. This filter is illustrated at 159*i*. The magnetic carbide is placed in the centre of the filter, and requires no renewal, and the water when filtered is drawn off from the bottom of the vessel. Another recent novelty in small filters is the ter of the well known Silicated Carbon Filter Company.

159.i



159.L

159.M

Before, however, dismissing the subject of filters, it may be of advantage to point out that these contrivances can be fitted upon the taps themselves. In some cases this will be found very beneficial. At Fig. 159*l* is drawn a low pressure silicated carbon filtering tap, for withdrawing water from the cistern or ordinary water-butt. Fig. 159*m* illustrates a filter constructed for the high pressure water service. This is an excellent article, and is connected direct with water main. Every drop of water, as will be seen in the section, is compelled to undergo three filtrations. It is made of iron, with an enamelled inside, and is readily cleaned out.

It not unfrequently happens that the emigrant has to undergo great privations in the matter of water supply. A portable filterer was not long ago patented in America, for use more particularly in San Francisco. This filter, which for its peculiarity, is sketched at Fig. 159*n*, consists of a cone-shaped bag, made of flannel or table linen, upon the inner surface of which is plastered a preparation of

159n

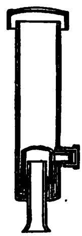
great porosity, chiefly charcoal. It is said to thoroughly strain about 40 gallons per hour.

The whole of the foregoing filters have proved successful, and are well worth an inspection by those interested in this branch of sanitation. Their several adaptabilities vary according to the kind of water which they have to deal with. The condensing apparatus for freshening sea water is also suitable for cleansing the water of rivers, ponds and wells—Normandy's patent marine aërated machine being an example of this class. Next to the purifying power of a filter is to be esteemed the ease with which it can be cleaned out.

PRICES OF CISTERN AND OTHER FILTERS.

Fig. 159*f*, to yield ½ gallon per minute, 30*s.*; 1 gallon, 40s.; 2 gallons, 60*s.*; 4 gallons, 90*s.*; 8 gallons, 180*s.* each.
,, 159*g*, to purify 200 gallons per day, 120*s.*; double filter, to yield 500 gallons, 220*s.* treble filter, to yield 750 gallons, 320*s.*; quadruple filter, to yield 1000 gallons, 420*s.* each.
,, 159*h*, Tank holding 35 gallons, 110*s.*; 55 gallons, 130*s.*; 100 gallons, 190*s.* 150 gallons, 250*s.*; 200 gallons, 400*s.*
,, 159*k*, price depends on size of tank ordered.
,, 159*i*, to hold 15 gallons, 21*s.*; 20 gallons, 31*s.* 6*d.*; 25 gallons, 42*s.*; 30 gallons, 52*s.* 6*d.*; 50 gallons, 76*s.* 6*d.*; 80 gallons, 105*s.*; 100 gallons, 126*s.*
,, 159*l*, 10*s.* 6*d.* each.
,, 159*m*, various prices.

There is a certain amount of security against the inroad of foul gas from the drains, in cases where the overflow pipe of the cistern connects with the drain in a more or less direct manner; but in figuring one or two of these articles I must repeat the oft-spoken warning against such a communication between the overflow pipe and the drain. It may, however, occur, that the overflow pipe does not lead into a drain conveying away soil or other very offensive matters, or that the water of the cistern is not required for drinking purposes. In such cases these contrivances might be useful in preventing whatever effluvia did arise from the drain. If the overflow pipe led very close to the gully grating these pipes would serve a good purpose. I do not say that they are not useful fixtures upon the overflow pipe, under even the most perfect system of disconnection from the drain; but I unhesitatingly say, that they are by no means to be solely relied upon as a preventive of the escape of sewer gas into the water tanks



159.p

159.q

At Fig. 159*q* is given an illustration of the overflow trap, supplied by Mr. Finch, of High Holborn. It is in principle the same as the Antill trap, shown at Fig. 80, page 36. The other design, Fig. 159*p*, represents the patent overflow arrangement of Messrs. Westo and Pinder, sold at East-street, Walworth, London. Here an inverted cup is fitted on the bottom of the outer overflow pipe. The inside of the regulator is made to contain some soft filtering material, such as wool or sponge. But it must be seen to be easily understood.

PRICES.

Fig. 159*p*, in enamelled zinc below, 2 feet, 11*s*. 6*d*. each.
,, ,, above, and not exceeding $1\frac{1}{2}$ diameter waste pipe, 13*s*. 6*d*.
If in charcoal iron, 5*s*. extra.
Fig. 159*q*, with locking grating, 1*s*. per inch diameter of waste pipe.

It will not be deemed necessary to enlarge upon the necessity of a hot water supply to a house, for, fortunately, it forms the exception to find a household unprovided with this sanitary appliance and means of comfort. I merely mention it to draw attention to the newly introduced hot water supply cylinder of Messrs. Braby & Co. (Limited), of Euston-road, London. This apparatus affords a complete guard against explosion. As the water circulates throughout the pipes hot water is obtainable at the shortest notice, and as the hot water is withdrawn from the top of the compactly arranged cylinder, the water drawn off is consequently of the highest temperature. These cylinders are fixed in a corner close to the kitchen fire, are open to inspection, and are well adapted for the supply of baths or sinks. The sizes made range from 39 in. to 48 in. diameter, and cost from three to four guineas.

HARD WATER.

It frequently occurs that only hard waters are procurable upon some estates. Some waters are permanently hard, others become soft by being boiled. The commonest reason for such hardness is the presence of carbonate of lime, and boiling separates the carbonic acid gas, and deposits the chalk or fur on the inside of the kettle. Such water is also very unfit as a detergent.

According to Dr. Cameron, horses which are accustomed to drink very hard waters suffer eventually from an abnormal growth of bone. For cooking purposes it is almost useless, it will neither soften meat in boiling, allow the extration of juices, or assist in the rising of yeast.

There is an infallible cure for water rendered hard in this way by the presence of dissolved salts or free acids. The treatment is very simple. Lime is added to the water, and when the excess of carbonic acid is neutralised, the lime which was just put into the water and the lime which was naturally present in the water are precipitated as a carbonate of lime. Organic matter, according to Professor Wanklyn, is often to be traced in the midst of the precipitated chalk. The best water-softening apparatus, applied to a cistern in combination with a filter, is the patent apparatus known as Danchell's, manufactured by the London and General Water Purifying Company. It is based on the above explained process of precipitation, invented by Dr. Clark. Here the insoluble chalk falls to the bottom, and the softened water filters through this material, and rises again into the tank in a perfectly soft state. These filters are, I understand, let out on hire.

RAIN WATER.

Some philosophers have greatly interested themselves in ascertaining whether or not the moon is a meteorological agent. Sir John Herschel says that there is a preponderance of rain during that part of the month nearest, so to speak, to the full moon. Statistics prove that in Germany the minimum number of rainy days occurs between the last quarter and the full moon. They "manage these things differently" in France apparently, for M. Arago has pointed out that the minimum number of rainy days occurs between the full moon and the last quarter. Possibly the latitude has a great deal to do with it. It may be of service to some reader to know that in England, according to Mr. Pengelly, who made a series of careful experiments extending over 74 lunations, or more than six years, that the greatest quantity of rain falls in the second quarter, the maximum number of wet days occuring in the third quarter, and the minimum number in the first quarter of the moon.

The rain water collected in the country is considered of great value, a chief reason of this being its comparative cleanness. Unfortunately the rain water of towns is too full of soot and other impurities to be used with advantage, and those who would only use this kind of soft water in the infusion of tea would be almost necessarily deprived of that beverage. The collection of rain water is, however, a matter of importance in the laundry, whether in town or country. Even in the stable its use is very beneficial. If used for nothing else than for garden use, or for the periodical flushing of the house drains, its collection will repay the trouble. Rain water is best stored in an underground cistern, built in a manner similar to that specified for the liquid manure tank at page 28. It need not be situated far from the walls of the building, and the overflow pipe from such tank should lead disconnectedly with the drain. Above the cistern can be fixed an ordinary pump. The common halfround, or ogee eaves troughs and down pipes, are made of cast iron, and usually receive a coat or two of mineral or lead paint; but much better rain water conduits are the galvanized cast iron gutters, now mostly adopted in iron buildings. Zinc pipes are also common enough, but are open to several objections. Perhaps the best kind of gutters and stack pipes are those supplied by the London Enamel and de Lavenant Patent Iron Company, of Bankside, London. These are coated inside and outside with a preparation of silica, and will convey the water in its pure state to the tank or cistern. I append the prices of these last mentioned, as they are not generally known.

Supplied Coated Inside and Outside.

	2 in.	2½ in.	3 in.	3½ in.	4 in	1½ in	5 in.	6 in.	
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	
Cast Iron Rain-water Pipes.	1 9	2 2	2 5	3 4	3 11	4 10	5 0	6 2	per yd. run.
Cast Iron Gutters, halfround	...	...	...	1 2	1 6	1 9	2 0	3 0	,,
Ogee	...	...	...	...	2 0	2 6	2 8	3 10	,,
Cast Iron Heads	2 0	2 8	3 0	3 6	4 0	4 6	5 3	6 3	each.
Cast Iron Shoes	1 4	1 6	1 10	2 2	2 10	3 4	4 4	5 6	,,
Cast Iron Elbows	2 3	2 6	2 10	3 6	4 0	5 3	6 3	7 0	,,

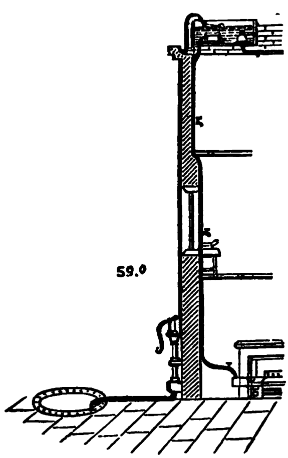
Whatever kind of troughings are chosen, the outlets leading to the perpendicular pipes should be fitted with zinc, or other perforated caps or roses, to prevent the passage of leaves and other impediments into the rain-water store; for these after a time decay, and form a

stratum of black mud similar to that deposited at the bottom of a pond. The rain-water cistern also requires a certain amount of ventilation. It is customary to cover over the tank with close flagging, and in such cases the water speedily acquires a bad taste, and a number of offensive worms are bred in the stagnant water. Above all, these cisterns should be periodically scrubbed and cleaned out, to remove the vegetation which collects on the sides, and the deposits of soot which in towns mingle with the water in its descent from the roof.

WELLS.

Before attempting to dig a well, I should advise the non-professional reader to consult the work upon that subject, written by Messrs. Swindell and Burnell, and published by Mr. Weale, as it will doubtless save him much expense in the long run. It is not always safe to employ the village bricklayer upon such work, for he will sometimes use common mortar, which will drop into the well and harden the water, besides otherwise proving his incompetency for the work.

59.o



An excellent system of laying on the water of a well to a house is drawn at Fig. 59*o*. This is, to fix one or more galvanized iron or slate cisterns at the top of the house. The cistern here copied is Atkins' patent house tank and cistern filter combined. The lift pipe to cistern is shown by the dark line outside the house, and the supply pipe to the various rooms by the dark line inside the building. Draw-off taps are shown fitted to the sinks and boiler. In cases where there is no cistern, a filter-box can be fixed to the top of the suction pipe which leads into the well, and this will serve to filter the well water in most cases very effectually. Where there is a cistern, the force pump does not necessarily require this kind of filter, as one placed in the cistern itself is preferable and sufficient.

ANALYSIS OF WATER.

Of late years much attention has been paid by chemists to the analysis of drinking water, and a complete revolution has taken place in the method of analysis. One of the most striking results arrived at is, that good drinking water is so wonderfully pure. In one hundred million parts of such water not more than six or seven parts of ammonia are obtainable. This ammonia is produced by the destruction of the organic matter in the water, and serves as a measure or index of the quantity of such organic matter.

It is very satisfactory to know that the chief large water supplies of our populous cities and towns do actually attain to this high standard of purity. Such is the case with the water of the New River Company as supplied to London, and also with much of the Thames water as furnished by some of the Thames Water Companies. The Manchester Waterworks, the Edinburgh Waterworks, the Chester Waterworks, and many others supply such water. Exceptions to the rule that a public water company supplies pure water have been afforded by the Southwark and Vauxhall Companies in London, and also by the Norwich Company, which a few years ago were found to be supplying very impure water. Although good water may have been yielded by the water companies, it occasionally happens that, in consequence of foulness either in the pipes or in the cisterns, the water which comes into domestic use is impure. It should therefore be particularly borne in mind that the cisterns require periodical cleansing.

In the country, and sometimes in towns, the water for domestic purposes is not provided by a public company, but comes from a well. Now, if the results of past investigation by our first chemists tend to re-assure us with regard to the water which is furnished by water companies, they no less warn us emphatically against well water. Over and over again well waters have been found in an impure condition, and, in fact, it is unsafe to use a well water without having it efficiently analysed. The presumption in respect to a well water is that it is bad, whilst the presumption relative to towns water is that it is good.

The necessity for an occasional analysis being admitted, a great deal depends upon how the submitted sample of water is to be taken.

Professor Wanklyn and Mr. Chapman recommend that it be sent to the operator in the kind of glass bottle called a "Winchester quart," a stoppered bottle of about 3 litres capacity. It should be previously cleaned out with strong sulphuric acid, and well washed with the same water that it is intended to hold. The bottle should then be filled, corked, and sealed, and kept in a cool or dark place until sent to the chemist, which should be within two days, if possible, of the sampling. In town-water samples of the water should be taken from the street mains. When the water of a pond or well is collected, the bottle should be immersed in the water, and the bottle mouth filled at some little distance below the surface. In taking the water of a river, the middle of the stream should be preferred, and the outlet of sewers and feeders carefully avoided.

Analyses of potable and other waters are sometimes attempted to be made, amateur fashion, by the head of the family, but these are scarcely to be relied upon, unless the operator has had considerable experience in such matters. It will be found cheapest in the end to pay the small fee charged by a proper consulting chemist. The Water Purifying Company of London supply a tolerably useful testing apparatus, devised by Mr. F. Hahn Danchell, costing from 10s. 6d. to 21s. each, which might be found useful as a preliminary to a more elaborate examination, or as a tolerably sound means of ascertaining the purity of the water for agricultural purposes. These cases contain approximate test fluids for ammonia, lead, lime, iron, sulphuretted hydrogen, magnesia, and organic matter, and are very easy of application. A more elaborate method of determining the presence of organic matter in water, is that published in the *Journal of the Chemical Society*, by Messrs. Frankland and Armstrong, in 1868. The one I should rely mostly upon is the ammonia process of Messrs. Wanklyn and Chapman, as explained in their treatise on the examination of potable water. The second edition of this work (Trubner & Co., 1870, 5s.) should find a place in every library, as it contains the amplest information, and is, I believe, the only work in existence which treats exclusively upon this subject. Professor Wanklyn also conducts the analysis of any water submitted to him, at the Laboratory, 3, Winchester-street Buildings, London.

As a practical illustration of the benefits derived from a careful analysis, I may mention the following case:—Being called upon to

report upon the sanitary condition of a house in the south-west of London, my attention was drawn, amongst other things, to the condition of the water supply. I found that the water of a cistern, situated above the upstairs closet, was used in refilling the hot-water circulating cistern belonging to a bath, and on inquiry I discovered that this water was withdrawn, by means of a tap, for certain culinary uses. Amongst other things, this water was used in the preparation of the baby's food. The cistern downstairs, which supplied the drinking water, was also very unclean. An analysis of both showed considerable impurity—the hot water, perhaps, ought to be distinguished by the epithet "horrible!" I give the result of the analysis made by the ammonia method:—

	Free NH_3.	Albuminoid NH_3.	
Water drawn from the tap of hot water cistern	·01	·24	Parts per million.
Water taken from the drinking water cistern...	·03	·15	
Normal pure water	·01	·07	

After this, the servants were forbidden to use the hot water for culinary purposes, and the other cistern was cleaned out.

CHAPTER XIII.

DAMP-PROOFING AND FIRE-PROOFING.

So very many of the older-fashioned residences, and even the modern competitively built houses, suffer from dampness, that a few lines illustrative of its cause and cure may be found of service.

By way of furnishing the reader with an example, wherewith to gauge the measure of this subject, let us suppose that he builds a dwelling and out-houses, one story high, and one brick thick, containing in all, say, ten reduced rods of brick-work. This would be equivalent to laying 45,000 bricks; and as it is now admitted that each of the commoner bricks can absorb one half-pint of water, it follows that, unless provided against by damp-courses or other arrangements, the building will be capable of holding, and will certainly hold, under certain granted conditions, over 5,600 gallons of water, which in weight would mount up to the high total of 25 tons, and would need, before the moisture could be evaporated, and the wall once thoroughly dried, the assistance of about three tons of coal, economically applied. Of course, it is not to be expected that all moisture can be kept from the walls; for even if the walls of the same house were built with the driest Aberdern, Cornish, or Wicklow granite, there would always remain about 570 gallons of water, distributed over the 3,060 cubic feet of walling. Walls of the same bulk, if built in some of the ordinary sandstones, would retain, in the natural way, as much as 1,500 gallons of water. The damage done by damp is not confined to damp spots and streaming walls, and general discomfort in the basement or ground floors only, for, owing to capillary attraction, it is on record, which cannot be gainsaid, that the rising wetness has been traced to the astonishing height of thirty-two feet. Only consider what a train of disasters might follow such a state of things as a house built upon a damp soaking site, constructed of porous materials, with the water uncheckmated in its progress upwards, and not only this, but totally unprotected from the *driving*, as well as the *rising* wet. The *Nemesis* of such carelessness

would be best traced in the blear-eyed and rheumatic ailing inmates, the miasmatic condition of the surroundings, and the dilapidated condition of the dwelling generally.

THE ARREST OF DAMP IN WALLS BY INTERCEPTION.

If we lived in such a climate as Africa, we should not require to be so particular concerning the bricks we used in our buildings, and might even imitate the Egyptians of three thousand years ago, who knew not Taylor, or his damp-proof courses, and whose sunburnt and other bricks used at Dashur, and similar places, made up of all the odds and ends to be had from the Nile bed, are just now, under Professor Unger's hands, rendering up the secrets of the past. But as we live in a climate which, it is acknowledged, gives us an annual average rainfall of 24 inches, or nearly 90,000 cubic feet upon each square acre, it behoves us to see that *our* bricks are, at least, properly made, well burnt, and that some sort of promising means are taken to ward off the damp, if only because *we* know that moisture in the cellar means a great reduction of temperature throughout the basement, chilliness most disagreeable in the sitting and bed-rooms, and, in the library mildew and rottenness.

The first proposition I can recollect made as being remedial against damp was the using of enamelled bricks, and the making of the joints with a composition of melted bitumen and fine sand or powdered grit. The bottom courses, including the footings, were to be built up in this way to the ground level,—rather an expensive preventive, it must be confessed. About four years afterwards, or in 1868, a Manchester gentleman proposed to manufacture bricks by combining asphalte with sand, and cementing them together by the medium of molten asphalte, or other bituminous material. A simpler proposal, and one easier carried out, was the one known as Hutchinson's, and consisted in coating half the length of the headers or bonding bricks of a wall with asphalte. But it would not be worth while going to this labour and expense; for though the damp would mostly remain with the outer stretchers and the face-half of the bricks, the moisture would still trickle down the joints and strike across through the mortar. Asphalte plays a very important part in the schemes for the removal of damp, and the reason is obvious, as any one will allow who can

recollect the difference between the dry shelter afforded during a soaking storm by a railway bridge, the uppermost ring of the arch of which has been well paved over with this substance, or with tar and plenty of pitch, and compares this covering with the dripping soffit stones of the older arches, where nothing of the sort interposed between the ballast or earth formation and the material of the arch. How quickly, also, is the water dried up from the asphalte paving of our cities. For price of an asphalte damp course see page 151.

Ten years ago, Mr. Forster proposed to construct bricks in two halves, putting a glazing mixture of powdered glass and feldspar on each half, and so burning them together; but I have not been able to learn if the idea was a successful one, neither have I seen any of these brick sandwiches in any part of the country. In 1866, Mr. Taylor introduced the glazed bricks, and proposed to keep down or keep out moisture by building walls with them in cement instead of mortar. Several enamelled bricks are now performing similar functions with success. The same may be said of the Staffordshire and the blue bricks generally, of the terro-metallic brick, and, to a certain extent, of the Bodmer's patent compressed brick. This last-mentioned kind of brick will ere long supersede, near London at all events, the ordinary stock brick; for the clay earth is fast being exploited out, and the experiments we have seen made with sand bricks, &c. in machines such as Fairburn's coal and brick compressing machine, have yielded bricks with which we can find no fault.

A French system of preventing damp from affecting the inside of walls was, by coating thin veneers of wood with paint, and fixing a sheet of glass upon them, making the whole to adhere upon the interior walls by the aid of linseed oil and litharge, or by means of plaster. A German treatment, similar to this, was the fixing of a sheet of glass by cement against the interior walls all round the building. Both ideas fell still-born upon the English market. Attempts like these for curing damp would be somewhat analagous to driving the *Cimex lectularius*, with some half-and-half insecticide, into the chinks of the walls, and trying to shut him up there by pasting over his retreat a sheet or two of thinnish paper.

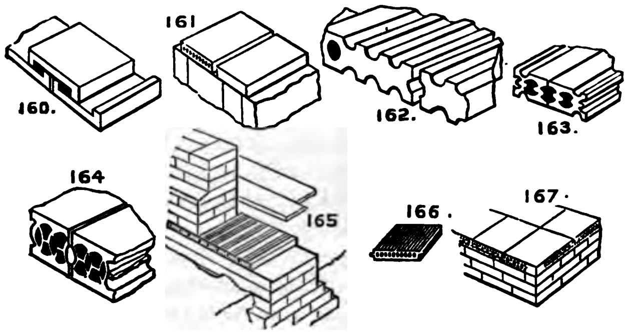
Another kind of attachment for the outside of walls was patented by Mr. Follett in 1869. He moulds terra-cotta into slabs, and works these in with the ordinary brickwork in such a manner as to keep

water out of the joints. These slabs he also glazes on the surface, to prevent any possible imbibition of water. This facing treatment is very common in Germany, and at the Greppin Works tiles for this purpose are made, in which density and non-absorbency go hand-in-hand. But this principle, if further pursued, will be found properly to belong to the subject of wall casings and wall tilings.

In order to prevent the attraction of water from the ground upwards, recourse has been had to what is generally called damp proofing. Scores on scores of concretionary mixtures have been brought out in America, for this and for roof coverings, and the publication of a perfect cure of this kind is as common as the irrepressible peat machine which is to make every adopter's fortune. A system projected, nine years ago, in this country was the evaporation of chalk, sand, slate, &c., and the subsequent grinding of the materials to powder. Melted bitumen was added to the powders, until the proper consistency was reached, and this mixture was payed over the walls, or compressed into a damp tile, and built in the wall. In 1863 was introduced to notice a damp preventive, made up of argillaceous earth, run into a paste with oilcake, hair, &c., ashes, or soot, and about an eighth part of cement. The inventor claimed for this material, when applied to foundations, hardness and impermeableness to moisture, and also a considerable amount of incombustibility. *Grandes promesses et peu d'effets.* May we not say the same of Mr. Lepreux's recipe for the cure of dampness in foundations, which was the application of a material consisting of six parts of gravel or flint and one part of resin, plaster, and sand? An apparently good foundation slab, as far as one can judge from a publication of the process and the material, is that patented by Mr. Jennings in 1869. He charges metal frames with slate powder and pitch, or other resinous matter. He then applies 200° Fahr. of heat, a great pressure to the square inch, and turns out the slabs two or three inches thick by the width of the wall. Not at all a bad material for slabs for this purpose would be the re-smelting and moulding into suitable sizes and thickness of the material known as slag,—the less brittle the slag the better.

An effectual system of preventing the upwards attraction of damp in walls is, either to cover them under the floor line with a coat or *two of* asphalte or pitch ; or one can bed the wall over with two or three

courses of slates laid in the best cement. This last is the handiest system, and is the one generally adopted by builders, who have always a stock of broken slates at their command. I may even go so far as to recommend this treatment to all buildings where a symmetrical damp course showing through the wall is not a desideratum. But it would have argued badly for British invention if no improvement had been devised, or rather if someone had not brought out some readier and easier application of the idea. This was done in 1859 by Mr. John Taylor, who devised the *specialité* now known as a damp-proof course. His original pattern is drawn at Fig. 160.



These were made of some non-absorbent material, of a length equal to the thickness of the wall, and of the width of a brick. A thickened border or flange projected from the surface of the tile, and two layers of these were laid upon the wall, just above the ground line, the first layer being laid with the flange uppermost, and the second layer with the flange downwards. As the width of each of the flanges was made somewhat less than half the width of the space between the projections, the tiles when set, left spaces between, which prevented the passage of wet along the joints between the tiles, and acted, moreover, as air chanels for ventilation under the joists or floors. He also introduced the two tiles shown at Fig. 161, the perforation not only performing the aforesaid functions, but assisting the tile to burn without warping.

Taylor's damp-proof courses are now made of highly vitrified

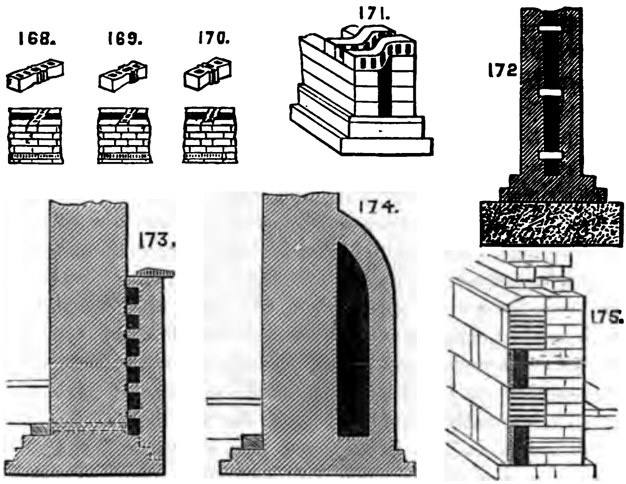
ware, in various widths, and in different patterns and thicknesses. Fig. 162 represents a portion of the damp-proof course, as made an inch in thickness. When the thickness of the tiles is increased to 1½ inches, the pattern is varied to the design at Fig. 163, and in cases where courses three inches thick are desirable, the pattern shown at Fig. 164 is adopted. The last mentioned thickness is the most useful when underpinning old walls, with a view of preventing the rising of damp, and if such tiles are well bedded and wedged up, this is effectually performed. Figure 165 is an isometrical view, showing the mode of using the tiles. These goods are manufactured at various potteries, at slightly differing prices; but the prices we quote below are those of the Broomhall Tile and Brick Company, Blackfriars, London, and represent the courses delivered in trucks at Wilncotte station, near Tamworth. At Fig. 166 is drawn the damp-proof course introduced by Messrs. Doulton and Co., of Lambeth. The departure from Taylor's pattern lies in the introduction of the tongue and groove joint; but as the air passage at the joint in Taylor's course is so shaped as to prevent the rising of the damp, and water would be more likely to creep up the matched joint of Doulton's course, I cannot see wherein consists the improvement.

These damp courses are generally laid throughout the whole thickness of the walls and sleepers, and about three inches above the ground-line. Angle blocks are also made for the corners of walls, as shown at Fig. 167. The Taylor course 1 in. thick, weighs 1 ton to 250 ft. superficial; the 1½ in. course, 1 ton to 170 feet superficial, and the 3-in. course, 1 ton to 130 ft. superficial measure. The crushing power of the 1½ in. course, as tested by Mr. Kirkaldy, is 176 tons, so that no fear need be entertained with regard to superincumbent pressure.

PREVENTION OF DAMP BY MEANS OF HOLLOW WALLS, DRY AREAS, &c.

The foregoing arrangements are, as may be seen, intended to serve for solid walls; but as a great deal of dampness is due to driving wet, or storm water, as well as rising wet, the interior of the house walls some distance from the ground would not necessarily be rendered impervious to water. I have alluded to the proposition of Mr.

Hutchinson; and since his time the same idea has been applied, but rendered suitable for hollow walls. The wall ties, or bonding bricks, are fast securing patronage, and for some purposes are really very serviceable. Fig. 168 represents Mr. Jennings' patent stone-ware



168. 169. 170. 171. 172. 173. 174. 175.

bonding bricks, as used in walls—such as, for instance, garden, stable, or cow-house walls,—when it is not necessary to be particular as to the ends of the bonding brick showing through the wall. But when this bizarre effect is objectionable, and at least one face wall is required, one end of the bond brick is faced with a closure of the same material as the rest of the wall; this is drawn at Fig. 169. If two uniform faces are indispensable, then, the bonding brick figured at Fig. 170 is used in the way shown, that is, with two closures. Of course, the bond bricks can be used in walls of divers thicknesses, the desideratum being the safe maintenance of a hollow between the outer and inner walls. At the bottom of the wall elevations in the last three figures, a Taylor's damp-course is shown. The above are all sold by the patentee, at his works, in Lambeth.

Another patent device of Mr. Jennings is exhibited at Fig. 171. Here he renders the interior independent of exterior weather in much

the same way, *viz.*, by building twin walls, and connecting them with an inclined brick, which, it is claimed, will prevent the moisture from passing from the outside wall to the inside, if the lower end of the bonding ramp is pointed outside. Doubtless, it will retard the passage of moisture; but I cannot see any real necessity for such superfine treatment.

A very similar arrangement was patented lately by Mr. E. Tutte, of Fareham, Hants, and a general idea of his system will be seen at Fig. 172. He commences by forming a foundation of concrete, a little wider than the footings of walls; and these latter built up, he commences at once a double wall, with a space between of 2½ inches. He then puts a slate damp course on the wall, about 6 in. from the bottom of the hollow work, but not across the cavity, as that is needed for mortar droppings. About 6 in. higher he begins to put in his patent ties, edgewise, across the wall spaces, the notched end downwards, and continues these every sixth course, 2 ft. apart, until the plate of the roof is reached, when he runs a heading course all round the building. Some extra precautions are of course necessary at the window and door openings, and at the chimney jambs and stacks. The stone window sills, especially, should not span the well hole of the wall. These ties are made both in slate and iron, and are said to answer every purpose. One tie is required for ever three superficial feet of wall.

A well-known manner of protecting the walls from underground damp is by the adoption of what are called dry areas. These are constructed by leaving a space between the main wall and a thin supplementary wall outside, which goes up to the ground level, and are occasionally joined together with a stretching brick. Fig. 173 will furnish an idea of what is here meant. Sometimes the dry area is formed in the shape of a curve, the top of the area wall dying into the main-wall a little under the ground line, flying buttress fashion see Fig. 174). At other times the area is widened from 4½ in. to 18 in., or even more, and the retaining wall is battered so as to resist the pressure of earth behind. In the latter case the bottom of the area requires to be well drained.

I have already alluded to Taylor's damp-proof course, and at Fig. 175 we show a new application of it, *viz.*, as a wall-casing up to *the ground floor.* This is intended to avoid the necessity of an open

dry area. The casing is bonded to the brickwork of the house with a border of the same vitrified stoneware, 9 in. high. These work in with the ordinary-sized bricks. The intermediate space can be made to any reasonable width, and the strength has been well tested. With the exception of the damp-proof course in the main wall inside the area, and the ventilating holes, the idea is the same as at Fig. 174, (a covered dry area) only that here we have system and special materials.

CURE OF DAMP WALLS BY EXTERNAL APPLICATION.

Nearly every family periodical has published a series of so-called infallible cures for damp walls: but were I to quote a tithe of even the earnestly-recommended cases, I should simply disgust my readers. Some of them, however, are not unreasonable; but others, again, lean towards the opposite pole. Who but a highly-imaginative dairyman would discover a waterproof cement in new sweet cheese, worked in hot water till it becomes an ungreasy slimy mass, and washed, further, in cold water, and kneaded by-and-bye at a hot stove with a quantity of air-slacked lime? Yet this is one of the many nostrums.

If the rooms are on the basement floor, construct a well-drained dry area round them, and put in a proper damp-proof course. If the building has no cellarage, underpin the wall 6 in. above the ground line with Taylor's 3 in. thick damp course. This will keep the damp from rising, and is the way in which many houses, &c., have been cured: notably the Almshouses in Church Street, Blackfriars, London, which, until so treated, were uninhabitably damp. If it happen that the walls are built of soft porous bricks, it will be necessary to coat them all the way up with some effective material; and this brings us to the treatment by external application.

The commonest mode of avoiding the effects of drifting wet, or remedying the over-porous nature of the wall material, is to slate or tile the walls or gables,—although this is not altogether satisfactory, and, moreover, destroys the beauty of the elevation. Use hard impervious materials, if you can, of course; but if you cannot do so, or unfortunately have not done so, proceed to render the outside of the walls waterproof. This can be done in several ways. The home-

brewed cure of the Americans for soft-bricked water-secreting walls, is to rub the surface down with bricks and cement water, and when all is smooth and the interstices well filled up, to paint the whole over. A similar treatment is observed in this country. A process described at a meeting of architects was the dissolution of ¾ lb. of mottled soap in one gallon of boiling water, and spreading this, in dry weather, flatly over the brick surface, and so as not to lather; and after drying for 24 hours, applying in the same manner a solution of ¼ lb. alum, melted in two gallons of water. The soap and alum decompose each other, and form an impenetrable varnish. Another process was the application, with a brush, of sulphurised oil, made by subjecting 8 parts of linseed oil and 1 part of sulphur to 278 degrees of heat, in an iron vessel.

Every one cannot, however, make up his own medicines, and must, therefore, buy them ready prepared. Hence compositions have often been introduced to notice. I will, by way of conclusion, mention two or three in which I have every faith, and which I have carefully watched.

One is the Encaustic Zopissa treatment of Szerelmey and Co., of 551, Oxford Street, London; which is, the filling up of the pores of the stones or brick with a solution, which is laid on in two different coats with an ordinary painter's brush. It indurates or case hardens the walls, if the expression is allowable, and enables the stone or brick to resist the chemical action of any atmosphere. The "No. 1 Liquid" is a colourless solution, impervious to rain and damp; the "Composition No. 2" is a substitute for oil paints, one hundredweight of which will thrice coat 125 square yards of wall. The other system is that of Gay & Co., of Alton, Hants, and consists of the application to the walls of their "Impenetrable Solution." This material is, like the last-named, a body-paint, and it can be had in any of the architectural tints or colours. One gallon will cover about 20 square yards of three-coat work. The petrifying liquid of the Silicate Paint Company of Liverpool, containing, as it does when dry, 90 per cent of silica, is also highly spoken of as a waterproofing solution. I recommend my readers to try these in preference to any of the expensive paints. There are several precautions which require to be observed in the use of these new processess; but if the simple rules sent out with the *paints are adhered to,* the results will be good.

PRICES OF DAMP-PROOF TREATMENTS.

LAWFORD AND CO'S. PATENT PREPARED DAMP-PROOF COURSE ASPHALTE.

¼ in. thick, 2*d*. per foot super.—½ in. do., 3*d*. per foot super.

SIZES OF SLABS.		18in. × 9in.	14in. × 9in	9in. × 9in.	4½in. × 9in.	
Fig. 162	1 in. thick		4*d*.	4*d*.	4*d*.	per superficial foot.
Fig. 163	1½ in. thick	5*n*.	5*d*.	5*d*.	5*d*.	
Fig. 164.	3 in. thick	8*d*.	8*d*.	8*d*.	8*d*.	

Fig. 168...13½ inches long 18*s*. 0*d*. per hundred.
Fig. 169...11¼ „ „ ...15*s*. 0*d*. „
Fig. 170... 9 „ „ ...12*s*. 6*d*. „
Fig. 172...In slate .... 6*s*. 6*d*. „
„ ...In iron........... ...16*s*. 0*d*. „
Szerelmey's Zopissa Composition, No. 2...55*s*. 0*d*. per cwt.
„ „ Liquid, No. 1 .... 5*s*. 6*d*. „
Gay's Impenetrable Solution ....12*s*. 6*d*. „ in any colour.

There are several ailments which are traceable to taking up one's abode in a newly-built house. The simplest test of the dampness of rooms is the undermentioned one of Dr. Coffee.

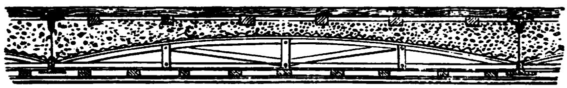
"Place 500 gms. of quicklime on a plate, leave it in the apartment, and if at the end of 24 hours this substance, which absorbs moisture very greedily, has not increased in weight by more than one-fortieth or one-fiftieth, the apartment may be considered fit to live in. In a damp or newly-built room it will increase in weight as much as 5 per cent."

FIRE-PROOFING.

A good house should be constructed in as fireproof a manner as possible, if only for the sense of security which is in consequence afforded. To wake up in the night and confound simply explainable noises with the crackling action of fire, is not an uncommon occurrence with any one in these days of match-built residences. As someone or another has pointed out, most houses are now, as a rule, built only to be burnt down. The present Building Act is not sufficiently stringent, and the sooner Wisdom calls aloud from the house-top the better. Nor should security be afforded alone to the rich, when floors and walls of hollow bricks or concrete, which are reasonably cheap, are known to be more or less incombustible. The rich man can purchase a greater immunity from fire by means of the iron and concrete combinations now so common, and what he loses he can replace, which the poor man can seldom do.

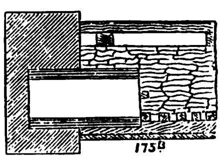
The cheapest kinds of fire-proof construction for use in cottages are

undoubtedly the hollow brick systems of Messrs. Bunnett and Warren. Specimens of each of these and others can be seen at the South Kensington Museum. But they are not sufficiently rigid to suit the larger sized houses, and, therefore, recourse has been had to iron and some cementitious material combined.

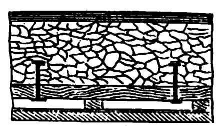


175a

The patent fire-proof roofing of Messrs. Moreland and Son, Old-street, London, is exhibited at Fig. 175*a*. Wrought-iron girders are placed at certain distances apart on the walls of the building, and resting upon the flanges of these beams are what are called bow and string lattice girders. On the curved surfaces of these last-mentioned girders corrugated iron sheeting is laid, and upon this a body of concrete sufficient to bring the whole to a level surface. Upon the concrete small joists can be laid, and the floor boarded in the usual way. The ceiling may be made, as here drawn, with joists and plaster in the ordinary manner, and so forming a flat surface ; but for cellars and attics the iron construction can be left bare and the plastering dispensed with. There is no doubt that such a system of flooring offers many advantages. The air-space between the flat plaster ceiling and the arched soffit of the corrugated iron is naturally sound-proof, and it can be used for ventilating and even heating purposes.



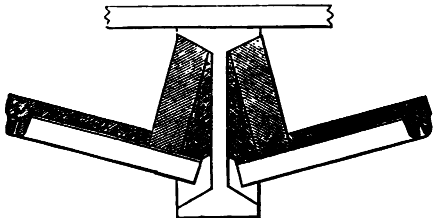
175b



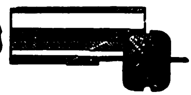
175c

Fig. 175*b* represents the patent fire-proof system of Messrs. Fox and Barrett, of London. Here rolled iron joists are substituted for the ordinary wooden joists, and are placed about two feet apart. Upon the bottom flanges of the irons are placed strips of wood, and upon these is laid the concrete, as shown. The floor may be laid of tiles, as in Fig. 175*c*, or joists of wood can be laid above the concrete and floor-

boards upon these, as shown in Fig. 175*b*. The patent systems of Mr. Nassmyth and Mr. Cheyne are somewhat similar to the above, but have iron plates or sheets of corrugated iron laid between the iron joists, instead of wooden strips.



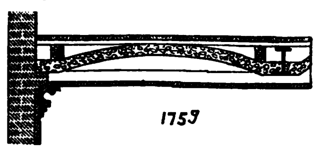
175d



175e

At 175*d* is exhibited the patent fire-proof ceiling and floor of Mr. Gilbert. In this system girders of iron are also used, and resting on socket bearers fastened upon the bottom flanges are corrugated arched sheets of iron. Brick-shaped pieces of stone or other material are then wedged between the underside of the top flange and these arched plates, and the space between these blocks and the upright part of the rolled iron joists is filled up with concrete. The corrugated iron is also covered to a certain depth with the same material. In the patent system of Mr. Walker, of Old-street, London,—which is, I believe, at present largely adopted in Paris,—the main beams are formed of timber enclosed by four Z-shaped irons, on the flanges of which the joists, six inches deep, are laid,—these being sandwiched between angle-irons. The flanges of these angle-irons carry square tiles, and on the tiles is spread concrete a few inches in thickness. The floor-boards are nailed upon the top of the wooden joists, and the ceiling laths, forming the key to the plaster, are fastened in like manner to the underside of the joists. The chief feature in this kind of fire-proofing is the retention at the same time of the usual wooden beams. This last method is drawn at Fig. 175*e*.

175f



175g

In the above kinds of fire-proof floors, common concrete will be seen

to play a certain part, but the chief reliance is made upon the iron beams and joists. A system in which concrete forms the only fire-proof material, is exhibited at Figs. 175*f* and 175*g*, and this is known as the Dennett arch. The concrete used here is formed of broken-up porous material, such as bricks or tiles, and this ballast is mixed with sulphate of lime or gypsum, and run in, whilst wet, on centering. Where the bearings exceed eight or ten feet, a beam of rolled iron is introduced. When the material has been left for a week or ten days, the centering is removed, and the floor can be finished with tiles, as drawn at Fig. 175*f*; but if a ceiling of plaster, and a wooden floor are required, the construction will resemble Fig. 175*g*. For a roof covered in with this material, see 159*v*, page 122. I have used the Dennett arch with great advantage. One grand feature of this system is, that vaults or domes can be constructed in the cheapest manner—even groined work would entail no extra expense. Again, when dry, this material will take any amount of decoration in colour or relief. The chief value of the system is, however, the absolute safety which the material affords from fire. The sulphate of lime loses but little of its cohesiveness by calcination, and water poured upon it when at a white heat hardly impairs its strength. The offices of the Company are situated at No. 5, Whitehall, London, S.W.

There are numerous other kinds of fire-proof constructions which would prove interesting to a person about to build, and these can for the most part be studied in drawings or specimens at the South Kensington and other Economic Museums. The newest system is that of Mr. Hornblower of Liverpool. The comparative cost of some of those which we have mentioned, as computed by Mr. H. M. Eyton, the architect, is as follows.

	Thickness of floors complete in inches.		Cost per yard. £	s.	d.
Wood joists, inch floor boards, and lath and plaster ceiling ...	11	...	4	8	6
Do. do. including pugging...	11	...	5	8	6
Brick arch 4½in. thick, with iron girder, and levelled for tiles...	20	...	4	15	0
Do. do. including boarded floor and lath plaster ceiling	24	...	7	0	0
Fox and Barrett's patent, with a cement surface...	9	...	5	18	0
Do. do. finished with boards	11	...	7	3	0
Dennett's patent, the top smoothed over with fine stuff	13	...	3	10	0
" " with tiled floor	14	...	5	0	0
" " if boarded floor, and with ceiling joists, lath and plaster	15	...	7	10	0

For outbuildings with wooden roofs, a very desirable material to use as a cover to the boards is, undoubtedly, the Danish asphalte roofing pasteboard, sold by Messrs. Atkinson and Michael, of Wharf Road, London, N. It resembles ordinary felt in appearance, but is thicker and more porous. When laid upon the boarded roof, it is subsequently paved over with the asphalte mastic, sold for the purpose by the same firm. Some interesting experiments have been made with this material. A roof covered with slates on rafters of wood, perished in twelve minutes after the ignition of the fuel placed inside the shed, whilst the roof covered with this felt remained undestroyed after the same amount of fuel had expended itself. It is sold in rolls 25ft. long, and 2ft. 9in. broad, and this quantity costs 6*s.* 6*d.* The asphalte mastic costs 9*s.* 9*d.* per cwt., and this quantity will cover a surface of sixty-five square yards. The nails required for fastening a roll of pasteboard are 500, and the cost of these is 4½*d.*

An experiment made with boards which had received a coating of Ransomes' silicious paint was reported in *Engineering* some time ago, and not only did the roof remain unhurt by the fire, but the boarding so treated resisted the fire to such an extent, that for a quarter of an inch in thickness the wood was completely charred. A piece of timber coated with this material and placed in the fire, will shew, when taken out, that the paint will remain shell-like upon the more or less charred wood inside.

With such materials in the market, it would be folly to persist in the use of the inflammable felting now mostly used. If, however, the cost is a bar to their use, the boarding can be covered with some approximate fire-proofing compound. A wash, composed of lime, salt, and fine sand or wood ashes is used in America as a protection to the wooden shingle roofs from falling cinders, and it is laid on with a common whitewash brush. The tint can be varied by the addition of the colours mentioned at page 30.

Several processes of treating timber so as to render them less inflammable have been and are in use, but they do not seem to make any headway. The same may be said of the fire-proofing of wearing apparel. A late patent for this latter purpose is that of Messrs. Carterow & Rimmel. The compound, which is chiefly a combination of chloride of calcium and the acetate and carbonate of lime, is applied in the size or starch, which is applied to the warp-threads

before weaving, and, after washing, renewed by dipping. It can also be applied to wall papers by an ordinary brush. In a powdered state it can be spread over a plastered or cemented surface whilst the walls are in a wet condition, or mixed with the rendering material. If used as an uninflammable coating for woodwork, it is mixed with the paint or varnish. The principle, in all cases, is the same,—the formation of a ceramic coating which will exclude oxygen.

The following suggestions, with reference to the prevention of fires, were given in the pages of the *Builder* for May, 1867, and as they are evidently the result of some study, I here quote them.

"Keep matches in metal boxes, and out of the reach of children; wax matches are particularly dangerous, and should be kept out of the way of rats and mice—be careful in making fires with shavings and other light kindling—do not deposit coal or wood ashes in a wood vessel, and be sure burning cinders are extinguished before they are deposited—never put firewood upon the stove to dry, and never put ashes or a light under a staircase—fill fluid or spirit lamps only by daylight, and never near a fire or light—do not leave a candle burning on a bureau or a chest—always be cautious in extinguishing matches and other lighters before throwing them away—never throw a cigar-stump upon the floor or spitbox containing sawdust or trash without being certain that it contains no fire—after blowing out a candle, never put it away on a shelf, or anywhere else, until sure that the snuff has gone entirely out—a lighted candle ought not to be stuck up against a frame wall, or placed upon any portion of the wood-work in a stable, manufactory, shop, or any other place—never enter a barn or stable at night with an uncovered light—never take an open light to examine a gas-meter—do not put gas or other lights near curtains—never take a light into a closet—do not read in bed, either by candle or lamp light.

"The principal register of a furnace should always be fastened open—stove-pipes should be at least 4 in from woodwork, and well guarded by tin or zinc; rags ought never to be stuffed into stove-pipe holes; openings in chimney-flues for stove-pipes which are not used ought always to be securely protected by metallic coverings—never close up a place of business in the evening without looking well to the extinguishment of lights, and the proper security of the fires—when retiring to bed at night, always see that there is no danger from your fires, and be sure that your lights are safe."

It is incontrovertible that the majority of fires arise from the use of candles. It is therefore strange that even isolated mansions are without the means of making gas, which is well known to be a safer means of lighting than either lamps or candles.

A portable or small sized gas apparatus is not necessarily costly, and they could be mostly worked in a place not larger than a moderate sized coal cellar. Amongst the latest attempts to make gas on a small scale is the Rutherford gas apparatus, which *requires* no brickwork in setting. It is usual to heat the two small

retorts over a gas stove, but of course a small fire grate can easily be substituted for this. The gas is manufactured out of mineral oil. A very useful gas generator on a small scale would be that constructed on the Myers principle, made by Messrs. Kendall and Gent, of Manchester. The gas is made from coal oil, and, besides the enhanced brilliancy of the light, it is reported to cost less than the ordinary coal gas. Where a larger quantity of gas is required to supply, for instance, the stables, outhouses, and labourers' cottages, as well as the house, a small gas works, such as is regularly manufactured by Messrs. Porter and Lane, of London, would be necessary.

As before stated, gas should be preferred to candles, be the house ever so small. In this respect we are greatly behind the Americans. The Columbia Portable Gas Company sell a machine which requires no fuel at all, but only an air compresser and an apparatus for charging the air with the gasoline or hydrocarbon vapour. The whole thing is not unlike a good sized churn; and another feature in it is, that it is self-acting.

It is unfortunate that householders in town or city should be driven to make use of candles because of the impurity of the gas which is offered for sale by gas companies, but the cure is in the hands of the consumers generally. A great deal, however, of the evil effects felt where gas is consumed, is due to the use of bad burners. The irrespirable products of combustion vitiate the air of the room to the extent they do simply because the burners permit the combustion of too much gas. The gas referees reported lately to the Board of Trade that the improvement in the burners will be "an important means of diminishing the pernicious effect of the impurities in gas." They estimated the gas rental of London at two millions sterling, and declared the loss caused by the use of bad burners was moderately put down at a fourth of that sum. They rarely found burners which gave out more than half the illuminating power of the gas, and some gave out only a fourth. There is no doubt that a great deal depends upon the kind of burners used, and some, which both economise and purify the gas, are sold at every gasfitter's. Stillthe fault in the quality of the gas does sometimes lie with the suppliers, and, for the benefit of the reader who may need it, I append, from the *English Mechanic* for 1871, a means of testing the purity of the article sold.

The test for sulphuretted hydrogen is easily made by moistening a strip of common writing paper with sugar of lead dissolved in distilled water. On exposing this for about a minute to a jet of gas issuing from the burner, the paper will be turned black or brown, if even a very small quantity of sulphuretted hydrogen is present. A solution of nitrate of silver is a more delicate test still, but the former will answer the purpose of the gas consumer. If ammonia is present a piece of yellow turmeric paper held in a similar manner over the escaping gas will be turned brown, or litmus paper previously reddened by vinegar or weak acid solution will have its blue colour restored. In order to ascertain whether carbonic acid is present, pass the gas through a solution of pure barytes in tincture of litmus, or through clear lime water, and if a precipitate is formed it will be either carbonate of barytes or carbonate of lime, and the presence of carbonic acid is at once revealed.

There is one means of averting the calamity of fire which is too often neglected. The article to which I allude is the lightning conductor. How often are roofs broken through by falling chimney stacks—roofs even fired, and barns and ricks completely consumed? The outlay is so small that I think no house of any pretensions, least of all a detatched house, should be without one.

Lightning conductors may be made of iron or copper. If of the former material, rods $\frac{7}{8}$ of an inch or an inch in diameter will be necessary, or bars 3 inches wide by $\frac{5}{16}$ of an inch thick; but if of the latter material, pipes of $\frac{1}{8}$ of an inch metal about $1\frac{1}{4}$ inch diameter will suffice. The best material are the $\frac{3}{8}$, $\frac{5}{8}$, and $\frac{1}{2}$ inch copper ropes made by Newall and Co. of London, costing, with copper point and insulating fittings, 1s., 1*s.* 6*d.*, and 2*s.* per foot respectively. The rods are carried through glass, gutta percha, or earthenware rings, and their upper ends finished with a copper ball furnished with spikes. The end should terminate in damp earth, and if a thoroughly moist place or a well cannot be found close to the building, the rope should be carried to the nearest place of this description in a dry trench formed of brickwork well filled in with charcoal or screened ashes.

There are several kinds of portable fire engines sold, as, for instance, the Hydronette, which is worked by the right and left hand, the suction end of the hose being put in the pail or cistern; and the Hydropult, which is worked whilst resting on the ground. But perhaps the most serviceable article is the portable fire engine sold by Messrs. Merryweather and Sons, of Lambeth. It consists of a powerful force pump and air vessel in a single barrel, united by 9 feet of suction pipe fitted with a strainer, and sold (together with 4 feet of flexible delivery hose, with branch pipe and jet spreader) for the sum of three

guineas. It is made entirely of gun metal, and is held by the foot, whilst the handle is worked by the right hand. The left hand wields the branch pipe, and the pressure of the thumb upon a small lever will project a jet of water to a distance of 30 feet or upwards at the rate of 6 gallons per minute.

An altogether different article for the reduction of fire is the Extincteur, sold by Mr. Sinclair, of New Bond Street, London. Carbonic acid gas, which is so antagonistic to fire, is generated in a vessel carried, knapsack fashion, upon the back, and from its compressibility is provided the power which delivers the gas-impregnated-water to a dis-distance of thirty feet. An experiment made by the War Office Authorities in 1868, proved that two men, in 7½ minutes with the aid of two Extincteurs, put out a fire which it took five men 15 minutes to extinguish with the Hydropult and an unlimited supply of water.

This chemical fire engine can be kept always charged. The cost is as under :—

	Weighing	Accommodating Pints of water.	Pints of C.A. gas.	£ s. d.
Size No. 4	70 lbs.	42	336	4 10 0 each.
„ 5	85 „	60	480	5 10 0 „
„ 6	118 „	80	640	6 6 0 „

A respirator for supplying a person with respirable air from a reservoir carried on the back, is sold by the same firm, and costs from £8 to £11, according to size.

Here are a few hints for the preservation of life from fire, just published by the Volunteer Fire Brigade of London.

"All the inmates of a house should be accustomed to reflect on the best line of conduct in the event of a fire, and should be made well acquainted with every outlet, both on the roof or otherwise, and in securing the house for the night, care should be taken to leave these outlets as easy of access as possible. Immediately upon an alarm of fire send for the nearest fire engine and escape. In the midst of much smoke, free breathing may be obtained by applying to the face a *wet* silk handkerchief, a worsted stocking, or other woollen substance, unfolded, or a *wet* sponge.

"It is also useful to remember, that smoke being lighter than air ascends, and in consequence, if on your hands and knees on the floor, you may find the air moderately clear. When unable to escape by the street door, or roof, all in danger should assemble at the front room window *closing all doors after them*. A window over the doorway should be selected rather than one over the area, and it should then be ascertained that every individual is present. In this position all should remain without precipitating themselves from the window, waiting the arrival of the fire escape, and even at the last extremity, sheets or blankets may be joined together, one end made fast to a piece of furniture; this will enable one person to lower all the others, and himself also without much risk."

CHAPTER XIV.

VENTILATION.

VENTILATION may be described as the introducing into a room of fresh, and sometimes warm and filtered air, in such a way as to insure its uniform distribution, without creating a draught, whilst at the same time permitting a constant withdrawal of the foul or vitiated air. Looking at some very pretentious dwelling-houses of modern date, it would appear that Chance alone presided over the department of ventilation. An inspection of many of the middle-class buildings,—for the most part erected, amateur fashion, by successful tradesmen, who have acquired a sort of Jack-of-all-trades education,—would almost bring one to suppose that Ignorance, which is seldom right, and often dogmatic, replaced Chance in the choice of ventilating media. Many of our public institutions are in this respect similarly monuments of mere luck. This is in direct contrast to the careful study which dictated the ventilation of the ancients. Let us take, for example, Egypt. Standing within the king's chamber of the largest Pyramid, and looking at the air-holes in the walls, can one help contrasting the wisdom of the early ages with the perversity of the present one? At Cairo—only a few hours furthur distant—you can discover ventilation most reprehensible in hotels and houses built by men who have pioneered the locomotive into the land of Goshen. At Alexandria, down the Nile, you will observe the same evils magnified many times over by settlers drawn from almost every modern nation. Wend now your way up the Nile again, and you will find the modern Egyptian in the enjoyment of the *mulguf*, which dates from the earlier dynasties, its open mouth welcoming in the fresh winds. The very tents of the Arabs are superior to some of our canvas pavilions.

The same moral will be learnt from India. The splendid palaces and temples of olden time are descanted upon by learned societies, and drawn by travelling students of the academies. Even the

punkah of the present day we can scarcely improve upon. The Moors will formulate the same lesson. The hall of the baths of the Alhambra has before now been lauded for its sensible arrangement ot curving roof and its wedge-shaped perforations. Turkey, the newest Eastern nation, has also a standing amongst those who may rebuke us. Why are we of the North and West so far behind? Is it because we had here, in Northern Europe especially, no wise ancestors, and, consequently, no traditionary transmission of health-securing inventions. Be this as it may, the perfection to which the ancients brought the subject of ventilation is perfectly surprising. One wonders if the old Orientals ever knew of the anemometer, and tested how quickly the air of their rooms could be renewed. Did they ever anticipate Dr. Lombard also, and employ the thermo-electric apparatus wherewith to determine the effect of different mental states upon the temperature of the brain?

I will divide my remarks upon ventilation under a few different heads, beginning with the simplest; but it must be understood that the subject can only be fairly treated of in a work by itself. All I propose to do is to indicate certain systems, and enlarge upon those which are most likely to benefit the householder. If the reader wishes to consult the several methods of ventilating large public buildings, such as theatres and prisons, the papers of Tredgold and Tomlinson and of Major Jebbs, will yield him every information. He can supplement these by a perusal of the French systems by General Morin, and the newer American methods of Leeds, Hayden, and Martin. The history of the many descriptions of ventilation successively tried in the British Houses of Parliament by Wren, Desaguliers, Chabannes, Davy, Lea, Wyatt, Deacon, Sylvester, and Barry would also prove excessively interesting. The steps taken to supply mines and light houses with pure air can best be studied in the works of Professor Faraday. The peculiar contrivances for ventilating ships, by windsails, pumps, and air-tubes, will be found in the "Merchant Service Scale" of Mr. T. Spencer Wells. And interspersed over the whole will be found descriptions of the exploded or the foolish and impossible theories.

The following remarks will be found generally useful. Do not expect a complete kind of ventilation by the adoption of windows alone. Foul air will partially escape in this way, but the counter

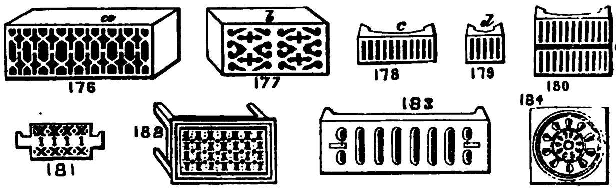
current will be draughty, and the hot air which ought to have escaped will be cooled by the inflowing fresh atmosphere and pressed down for re-respiration. The ordinary method of ventilation is to admit fresh air by openings in or near the floor and to afford openings in the ceiling or roof by which the hot air can find its escape. The lower openings into a room should be at least as large as the upper one. Dr. Cameron recommends the former to be twenty-four square inches and the latter twenty-five square inches for each individual; but it is scarcely sufficient. Whether these inlets and outlets take the shape of air-bricks or air-tubes, they should be sufficient in number to suit the summer ventilation, as in winter the supernumerary ones can be partially shut off. The warmer these upper tubes are made the quicker will be the exodus of the respired air. The ceilings of large room should be coved, and the centre furnished with an opening covered with a moveable register plate. Flat ceilings are objectionable for long and wide rooms, and coffered ceilings are not to be thought of unless each coffer or deep panel be treated as a separate roof.

For the information of the reader, I have compiled the following table, as illustrating the cubic space allowed for certain classes of inmates:—

Ordered by.	Class of Inmates.	Class of Buildings, and Condition of Health.	Space in cubic Feet.
The Legislature.	Soldiers.	In permanent barracks at home ...	600
	,,	,, ,, ,, in the tropics	1,500
	,,	,, ,, hospitals	1,200
	,,	,, wooden ,, ...	600
	,,	,, ,, huts	400
	Civilians.	,, lodging houses, when healthy...	300
	,,	,, ,, ,, sick ...	500
The Poor Law Board.	Paupers.	Healthy...	300*
	,,	Lying in women...	1,200
	,,	Sick...	850
	,,	,, offensively so	1,200
	,,	Infirm, night and day in the same room...	700
		Infirm, able to move elsewhere in the daytime	500*

* These require additional day room accommodation.

VENTILATION BY AIR BRICKS.



These articles are chiefly used for insertion in walls, as for instance, under the line of floor, in order to ventilate the space there, and prevent dry rot in the timbers; between the joists of the pugged upper floors; for a similar reason in the soffits of overhanging roofs, in order to induce a necessary change of air in the loft-space which is shut out from the attic rooms; also in larders, knife-houses, and the like. Placed at the very top of the wall, they are especially useful in ventilating the water-closets. The sliding kinds are mostly used for fresh air inlets at the line of floor skirting, in conjunction with vents in the roof or ceiling. In this case such a pattern should be chosen for the lower one as will break up and separate the entering air. In order to avoid draughts they should, moreover, be freely used. When they are required to ventilate a place like a coal-cellar or out-house, a single brick can be used, flush with the outside, and the wall bevilled at the bottom and sides, so as to enlarge the inside aperture. When used as inlets to a room or passage, they should be used double, one inside and one outside, and flush with both wall surfaces. When the rooms are fed with artificially-warmed air, the pipes or flues should be fitted up with air bricks having piercings of a minute pattern. In cases where a very ornamental and open patterned air brick must perforce be used, a piece of zinc can be fastened to this or the outer brick, or half way between, having about 100 perforations to the square inch. Built above each other, these contrivances are admirably adapted for placing before the air-shafts which feed the patent stoves drawn at pages 189, as the air is divided by impinging against them, and a rush of cold air prevented. They will also keep vermin out of the air-ducts. Fitted up with a charcoal box, they can also be made to purify the air. This will be especially desirable in cases where

children's or servants' bedrooms communicate with each other in this way near the cornice, and when it is desirable to protect the rest of the chambers from one in which an infectious disorder is raging, and when it would not be wise to altogether shut off the connections. How often have we seen a water closet ventilated into an hotel bedroom, and shuddered at the risk which we were running.

An excellent mode of ventilating a wooden or even any other temporary building is to introduce air-bricks such as the above on a level with the floor inside, through the wall. A good influx of air is thus obtained where the air cannot descend again. The air should also be allowed to pass up between the inside and outside boardings, and find a vent out of similar air-bricks fixed in the inside lining at the ceiling level. There should be no air-bricks in the outside boarding opposite these last-mentioned bricks. If there is a ceiling, a flap-door working on pivots, or a register plate worked by a cord and pulley, should be fixed in it at intervals. It might be supposed that the fresh air which enters from the ceiling would descend and prove mischievous, especially in a schoolroom; but it is so warmed in its ascension between the close boardings, that it even assists in the withdrawal of the respired air.

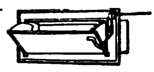
These air-bricks afford the very simplest means of ventilation, and yet they are desperately abused, and introduced into all sorts of improper places. For instance, in the stable it is common to put a large air brick in the wall, just over the manger, the result of which is, that either the impure air is always finding a vent there, close to the head of the animal, or a gust of cold air is rushing in. I have introduced them with benefit *under* the manger, and to the evident enjoyment of the animals concerned, taking care, of course, that the constant draught did not depend upon these bricks, but devolved rather upon the windows far over their head.

Fig. 176 represents a terra-cotta or stonework brick, common brick size; and Fig. 177 an air-brick made to suit various-sized openings. These are of the kind made by Mr. Jennings, of Lambeth, but similar ones are made at all the potteries. These air-bricks are cheaper than iron ones, need no painting, and will not rust, and so stain the walls; but if they have a fault, it is that they are easily broken.

An iron air-brick is shown at Fig. 178, a half air-brick at Fig. 179, and a double one at Fig. 180; and if these are galvanised—and they

should invariably be so protected from rust—they are to be recommended in preference to those made in stone-ware. A grating air-brick of iron is also shown at Fig. 181. What is called an air-grating, with a loose frame, is drawn at Fig. 182, and its use is obvious. Sometimes these iron air-bricks are made to slide as at Fig. 183, where one is drawn half open. This kind of ventilator is also made circular in pattern, and with or without the square plate drawn round Fig. 184.


185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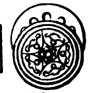
187


188

A system of creating a draught close to the ceiling is shown at Fig. 185. In this way a current of fresh air is directed along the ceiling, and presses the air below to the fireplace. I should not recommend this kind of ventilation to be tried indiscriminately. The larger orifice is outside, and is closed up by a double or treble air-brick, or a piece of wire gauze, or perforated zinc; and the smaller opening inside the room is fitted up with the Sheringham ventilator, sold by Messrs. Haywood Bros., Borough, London, and a view of which is given at Fig. 186. A patent draughtless air-brick, made by Messrs. Comyn, Ching and Co., is drawn at Fig. 187. It is merely a metallic box, with a wire gauze cover, and it is used in the inside of a room in concert with the ordinary air-brick outside the wall. A circular inlet draughtless ventilator, by the same makers, is shown at Fig. 188. The front disc within the room moves in and out by a screw pin and socket, and can be partly or entirely closed by this means.

Fig. 176. Size, 9in. × 3in. × 22½, unglazed or red glazed, 30*s.* per cwt.; black glazed, 35*s.*

	9×6 in.	12 × 6 in.	12 × 9 in.	14 × 6 in.	14 × 9 in.	14×12 in.	18 × 6 in.	18 × 9 in.	18×12 in.	18×18 in.
	s. d.	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*
Fig. 177, each	1 6	2 6	3 3	3 3	4 0	6 6	5 0	6 0	10 0	12 0

The iron goods are sold at per cwt.

	Size of iron box inside frame	9×3 in.	9×6 in.	13½×3 in.	13½×6 in.
		s. d.	*s. d.*	*s. d.*	*s. d.*
Fig. 186	Plain iron double pulley, each	3 6	5 0	5 0	6 0
	Galvanized „	5 0	6 9	6 9	9 0
	Japan bronzed „	4 6	6 0	6 0	7 3
	Japanned white and gold „	5 9	7 6	9 6	10 0

Fig. 187. Size, 10in. × 4in., 7*s.* 6*d.* each.

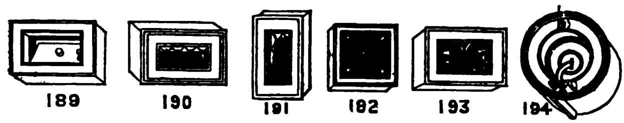
„ 188. 7in. diam., bronzed iron, 7*s.* 6*d.*; bronzed brass, 18*s.* 6*d.* each.

VENTILATION BY VALVES.

During the frightful visitation of cholera in 1849, Dr. Arnott published his famous letter upon the use of the chimney in withdrawing, pump-fashion, the heated and impure air of a room. There is no doubt that this contrivance has since saved thousands upon thousands of valuable lives. Its greatest merit is, perhaps, its simplicity. It has been several times described as inviting the smoke to escape into the chamber, but that was foreseen by the inventor before he recommended it to the then Board of Health, and the fault has been since overcome by the adoption of the improved valves. The mode of fixing these ventilators is very simple. An aperture is cut into the flue at the chimney breast, near to the ceiling, and one of these valves is built in. When there is a fire in the grate and the draught considerable, the balanced valve opens inward to the flue, and the heated atmosphere is drawn off. The free action of these valves depends greatly on the presence of a fire; but they are nevertheless useful, even when a fire is not lighted, as the air in a room is higher in temperature than the atmosphere outside. In some cases a draught is compelled by lighting a small jet of gas in the aperture of the chimney breast, or entrance to the vent; but the general practice is to attach a cord to the valve, and, when a fire is absent, to regulate it in that manner by the hand.

Arnott's valves are now made by numberless firms, inclosed in boxes exhibiting any quantity of ornament, to suit the taste or purse *of the buyer.* Fig. 189 shows a plain front without a trellis; and

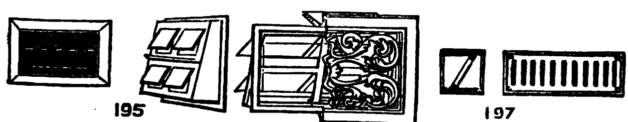
Fig. 190 a moulded front, with a trellis, both of the oblong pattern. Fig. 191 exhibits what is called the vertical valve, and Fig. 192 the



189 190 191 192 193 194

square ornamental valve. At Fig. 193 is given a sketch of the article mostly sold for use in large rooms. I may as well mention that the Arnott valve is also made in the circular form drawn at Fig. 194.

A specially contrived valve of this sort, called Boyle's Patent Ventilator, is shown at Fig. 195; and here the valves, instead of being single, are quadruple, and in place of being metal or silk, are composed of mica, which is not only light, but rigid, incorrodible, and sensitive to a degree, thus fulfilling all the necessities of the case. We give both a view of the front, and also of the valves at the back, which face the inside of the flue. This is sold by Messrs. Comyn, Ching & Co., of Upper St. Martin's Lane, London. Another of these mica-valved outlet ventilators is sketched at Fig. 196, and represents that sold by Messrs. Billings & Co., of Hatton Garden, London; the



195 196 197

valves are hinged to the iron frame with copper wire in the usual manner. An improved valve, chiefly used for ventilating stables and cow-houses, is that drawn at Fig. 197, designed by Mr. Armatage, and manufactured by Mr. Fardon, of Leighton Buzzard, Beds. It is the size of a common brick, and behind the perforated front moveable plate is a perforated oblique diaphragm—a thin, india-rubber hanging valve being placed between them, which arrests any gust of air from outside, and opens automatically to take away the air which has been breathed.

	No. 189.		No. 190.		No. 191.	No. 192.	No. 193.		No. 194.	
	11×8	16×9	12×8½	16×10½	12×6	8¼×8¼	17×13½	25½×18½	8	11
	s. d.	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*
A	4 6	7 0	6 0	8 6	5 6	5 6	16 0	30 0	4 0	6 0
B	7 0	10 0			8 0	8 0				
C	6 0	9 0	7 6	11 0	7 0	7 0				
D	8 0	11 6	9 6	13 0	9 0	9 0				

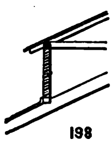
A. Plain iron. B. Galvanized. C. Japanned bronze. D. Japanned white and gold.

For prices of brass fronts or brass trellis, inquire of the makers.

	No. 195.			No. 196.			No. 197.
	11×7	11×11	16×11	11×7	12×8	15×10	9×3×2½
	s. d.	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*
Each.........	12 6*a*	21 0*b*	25 0	4 0	12 0	30 0	2 6
	Brass front plates.			Cast iron.	Ornamental		

a common patent at 6s. 6d. *b*, do. do. at 9s.

VENTILATION BY LOUVRES, ETC.



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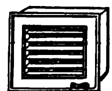

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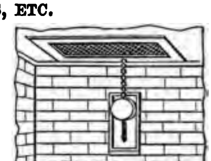
200



201

Louvres are generally of wood, iron, or zinc, and are either fixed fast in the frame, or made to revolve by the action of a rod. A piece of a louvre-framed roof is shown at Fig. 198, and it is simply the Venetian blind on a Brobdignag scale of inches. A ventilating louvre near the roof, 16 inches wide, and affording four feet of ventilating outlet for each animal, was strongly recommended in the Report of the Government Commissioners some little time ago, for adoption in stables, &c., where there was no loft or second storey.

A small Venetian ventilator, made and sold by Messrs. Hayward, Brothers, is shown at Fig. 199. They are generally fixed immediately under the cornice in the inside of a room, and on the opposite face of the opening outside the wall is inserted an ordinary air-brick. What is known as Moore's glass ventilators are also most useful for fixing in window squares; these can be had of any glazier, and need no description.

Messrs. Musgrave, of Belfast, have patented a very useful inlet ventilator for stables. By putting one over the horse's head near the ceiling, a good supply of fresh air is got without any risk of cold down-draught. Their ordinary pattern is figured at Fig. 200, and it is also made with a counterpoise to fix in the wall, so as to faciltate opening and closing. Besides the frame and the moveable glazed sash, (shown partly fallen down) which is sold ready for screwing inside the stable, a perforated grating is generally supplied with it, to insert in the wall, opening outside, and the combination is very beneficial. At Fig. 201, what is called Musgrave's patent outlet ceiling ventilator is drawn, and here is shown the counterpoise for opening and shutting —its object is to carry off the vitiated air, and still prevent a down-draught.

Mr. Cottam's system of stable ventilation is rather different to the above. His inlets are through perforations made in an iron pipe which runs round the stable about twenty inches above the ground, and therefore just under the mangers. Sliding gratings outside admit the air to the funnel-shaped mouth of this pipe. A sliding ventilator is likewise fixed in the ceiling, and the shaft above it conveys the exhaled air outside the roof.

The system of stable ventilation practised by the St. Pancras Company differs a little from both of the above mentioned. All three can alike be made to fufil the conditions laid down as under by Colonel Fitzwygram.

"Whilst purity of air in a stable is absolutely essential, the maintenance of an even and moderately warm temperature is also a matter of great importance.

In a well drained, well paved, well ventilated, and cleanly kept stable the temperature may generally be maintained at from 50° to 60°.

Some regard should be paid to the state of the external atmosphere—with the thermometer, for instance, at zero out of doors a stable would be injudiciously warm at from 50° to 60°, although that temperature may be taken as a fair average for most seasons of the year."

PRICES OF ABOVE.

	Size of box inside frame	9×5½	10½×7¾	14×9	18×12
		s. d.	*s. d.*	*s. d.*	*s. d.*
Fig. 199.	Plain iron	9 0	13 0	16 0	35 0
	Japanned bronze	11 0	16 0	18 0	40 0
	Galvanized	12 0	17 0	20 0	42 0

Made also japaned white and gold, with brass trellis fronts.

Fig. 200, mounted in iron frame to screw to wall, 33in.×13 in. .... 13s. 6d. each.
Ditto ditto Doub'e size, lower panes, fixed 33×22 ... 20s. ,,
Fig. 201, complete with counterpoise .... 15s. ,,

VENTILATION BY AIR SHAFTS.

It would serve no purpose to enlarge upon this head, as ventilation by air shafts is so well understood. They are eminently satisfactory under certain conditions. A convenient example is given at Fig. 202, which exhibits Messrs. Musgrave's patent system of stable ventilation. Entering the stable at A, through the valvular ventilator figured by us at Fig 200, and striking along the ceiling, the fresh air drives along before it the heated and breathed air of the horses, through the ceiling ventilating outlet which we gave at Fig. 201, into a horizontal air-chamber, which runs along the floor of hay-loft, and receives the vitiated air of all the stables. The outlet is at the roof at B, and these outlets are prepared to receive the foul air shafts. A more ornamental outlet, with vane, on this principle, is shown at Fig. 203. This system of ventilation is admirable in its way for a first-class stable; but it is not more effective than simple louvres or properly placed windows and air-bricks. Just in the same manner, whilst no one could doubt that cleanliness and neatness combined are brought about by the covered stable gutters and system of pots introduced by Messrs. Musgrave, Cottam, and the St. Pancras Iron Company, still not a less effective and a cheaper method for farm horses would be an open channel, with a quick fall, connected with a proper trap outside, to the main drain. The system of stable ventilation adopted is in a similar way practically decided by the amount of neatness and straw-plaiting required there, *i.e.*, by the depth of the pocket.

Roof ventilator at B, No. 202. plain, 14in. square, 65*s.*; 18in., 85*s.*; 22in., 100*s.*
Fig. 203, 11ft. 6in. high, with vane, &c., complete, £15.

Another system of ventilation by air-shafts is drawn at Fig. 204 and is that known as Pott's Cornice Ventilation. He makes the cornice of metal with two ornamental perforations running the whole

length, one of them forming the top or ceiling member, and the other the bottom or wall member. The ceiling perforations remove the vitiated air, and those in the wall portions of the mouldings convey the fresh air into the room.

Mr. Potts (of Handsworth, Birmingham, and Charing Cross, London) thus describes his invention:—

A hollow cornice runs continuously round the room, as the ordinary plaster cornice does. This metal cornice is divided longitudinally the whole length into two channels by a plate attached to the lower one. The fresh air is admitted into the pure air channel, or lower chamber, through openings in the wall, and descends into the room near the wall line through the perforation at the back of the lowest member. These perforations are invisible from the front, and being stopped immediately in front of the openings in the wall, the air cannot fall by a direct stream into the room, but is directed along the channel, and descends by its own gravity, and becomes diffused imperceptibly through the room—because, when first admitted, it is heavier than the vitiated or heated air within, and consequently flows freely in, but in descending it becomes warmed by coming in contact with the warmer air. The upper channel communicates with the smoke flue or air-shaft, or other extracting channel; it is perforated continuously along the face with ornamental patterns. The vitiated air, whether from combustion or the human breath, rises, when given off, to the highest point, is there drawn by the outward current through the perforations into the channel, and conveyed away by the air shaft or flue. It encounters no opposition to its exit, as the cold air coming in descends for a considerable distance close to the wall line, and is admitted at a lower level, and so assists instead of retarding the escape of the vitiated air.

I have known this method to fail, and I have known it to succeed admirably, just as the different systems of ventilation will do. There is a wrong way of using a right article, as everybody knows. A similar mode of ventilation is that known as Mr. McKinnell's. It consists of a tube within a tube,—the inner one, which conveys the vitiated air, being higher than the other. The fresh or pure air enters at the lower rim of the outer tube, and descends the annular space until it meets with a rectangular flange, which forms a flat disc, some inches wide, running around the open well hole of the central tube by which the impure and heated air escapes. By this means the fresh air is made to spread along the ceiling and descend by the wall to the floor of the room.

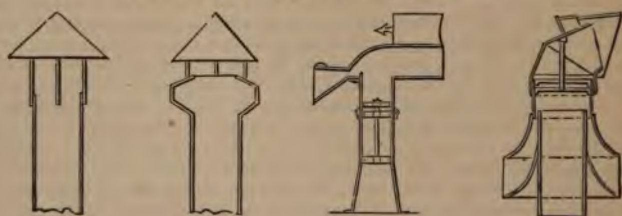
The ventilation introduced by Mr. Potts deserves a trial in, at least, the larger rooms of a house. There is no doubt that it can be successfully applied also in smaller rooms with necessary care. I should myself prefer the air to enter lower down. Mr. Robson, the

architect to the London School Board, speaks highly of Mr. Potts's system. He says:—

"Buildings originally erected without proper provision for ventilation cannot easily be treated on any other system. Some would involve their being half gutted. I can speak strongly in its favour for facility of application, sightliness, economy of first cost, and self acting properties.

"If universally applied to bedrooms, night nurseries, &c., lighted by gas (and perhaps the disadvantage of low ceilings), it would tend to improve the health of myriads. In the case of new buildings, where warm vertical air flues can so easily be provided, its action must be so perfect as to induce a very general adoption of the principles of the system."

VENTILATION BY COWLS OR TURRETS.



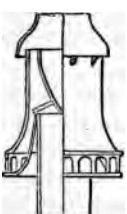
205 206 207 208

The ascension of vitiated air has been so long understood, that short shafts for its conveyance outwards through the roof, are widely known and extensively used. The crude idea was merely a cylinder with a cone over, such as is used over small stove pipes. See Fig. 205. Later on came what is known as the Tredgold pattern, with its inclined faces under the cap, up which the wind rushes to assist in the expulsion of foul air. This shape is sketched in Fig. 206. Innumerable devices afterwards followed, and we will mention a few of the best—those which have proved commercial successes.

There are several general remarks which should be made by way of an exordium to any description of this system of ventilation; and concretedly put they are as follows. Fresh air ought to be prevented from finding admission at the top of the rooms so ventilated, as the used-up air will not otherwise be got freely away, but will rather be blown back, and thus increase the deleteriousness of the atmosphere. Combined with these turreted air withdrawals, there should also be inserted near to the floor, a proper air inlet contrivance, so as to afford a constant diffusion of cold air. These inlets should be sufficiently *numerous* and not too large, and should also be so placed that

no inconvenient draught should strike into the room. They should, moreover, be so constructed as to be regulated at will. Any of the inlets previously figured would serve the purpose; and, in preference, we should use double air-bricks of different patterns, or finely apertured ones, which would serve to break up the column of air, and distribute it as if through a fine rose. Lastly, the drainage of the floor should be especially seen to, or the sewer air will be sucked or pumped up to the roof, through the rooms.

A late improvement in these forms of ventilators is shown in Fig. 207, and consists in the application of a cowl into which the funnel is made to project. The cowl is not only open at the large end, but has an opening also at the back, in the shape of a cone. The air passes from the small opening in the back of the cowl over the top of the air shaft, and at right angles to it, and as it then expands, it encourages an increased draught in the ventilating shaft. Back draughts are prevented by the regulation of the length of the hood or cowl. The inventor and patentee of this simple contrivance is Mr. Charles Wenner, C.E., of Horwich, Lancashire—not that the principle is entirely new, as the blow-pipe action of the back aperture across the ascending shaft has been recognised before. A rather more complicated hooded ventilator, one very largely patronised in France, the invention of Mr. Noualhier, and intended by him to be used in extracting gases, vapours, or foul air, from infected or confined rooms, is drawn at Fig. 208. A round shaft fits, for instance, in the roof of a sluggishly ventilated room having its upper part surrounded by a concentric tube, connected with curved plates in the shape of vanes, so arranged as to guide the air escaping up the shaft into the space above, and thus producing a circular current of air, and a partial vacuum in the upper tube.


208 *a*

A ventilator which has won golden opinions in Germany, and is making considerable headway in this country, is the Deflector, drawn at Fig. 208*a*, the patent of Messrs. Windhausen and Bussing, and sold by Mr. Strange, of Cranbourne Street, London. It is calculated to effectually cure a down draught, and will also serve as a smoke-preventing chimney pot for the same reasons. I figure it (one half being in section) because of its peculiarity.

Any one who has been pushed up into the attics of a London hotel, during cattle show week, and has amused himself when at his toilet by a survey of the many-patterned chimney pots, has doubtless been rather surprised at their number, but were he to supplement these enforced regards by a forenoon's study of the different ventilating contrivances produced even during the last ten years, and having the same external appearances as these pots, he would be simply astounded. I must be excused from a pen and ink parade of all these foul air exterminators, and allowed simply to review two or three ventilators which I have seen, and know to successfully fulfil all that is claimed for them.

209

210

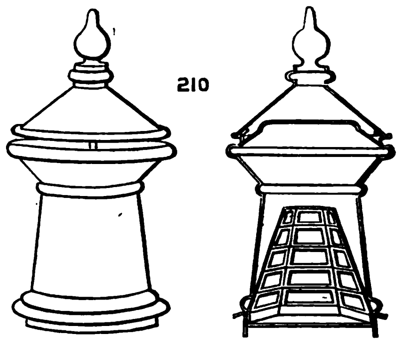
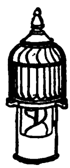


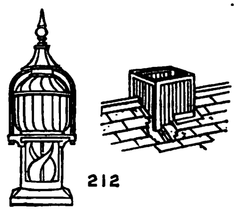
Fig. 209 represents a section down the centre of an improved self-acting turret with valves, made by Messrs. Billing and Co., Hatton Garden London. A galvanized cylinder is made to contain two cones, one within the other, and to form a windguard and protector to the valve, which is seen below, and which is composed of a number of small mica doors, copper-hinged to a cast-iron framing. Above the lower cone will be noticed an escape hole for the rain, so that no disagreeables of this sort can occur.

The hot air rushes up the shaft from the room, and passes through the valves, finally reaching the atmosphere at the circular space between the cones. They are largely used by the Government, and are made to fit shafts of from 6in. to 20in. diameter. Another very good turret ventilator is that drawn in elevation, and also in section at Fig. 210, and known as Boyle's Patent, and manufactured by Messrs.

Comyn, Ching, and Co. Here, also, the valves are of mica. The chief difference between this and Fig. 209 lies in the arrangement of the cones above the valve frame. Both of them recognise the necessary laws that govern this system of ventilation.



211



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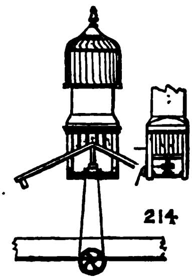


214

There is a first-class article of this turret class, known as the Archimedian Screw Ventilator, which is greatly in use here and on the Continent, and is made and sold by Mr. J. Howorth, of Farnworth, Lancashire; but here are no valves, and quite another mode of operation. The screw compels a never-ending up-current, so that the hot and impure air is continually removed, whilst the continuity of the same up-current prevents down-draught and its evil effects. The ventilator is so sensitive that the least wind will cause it to revolve, and beget a change of atmosphere. The side vanes of the hood let out the foul air, and prevent rain from obtaining entrance, and the curved vanes on the top of the hood revolve with it, and so generate a strong up-current. Fig. 211 shows a plain-pattern ventilator, and made with a round base, so as to fit on any round tube or piping. Fig. 212 exhibits the same ventilator, only turned out a little more ornamentally, and alongside is shown the wooden base, which is secured to the raftings of a building, and is sold with it. As the action of these ventilators is especially imperfect unless fresh air is admitted at the lower part of the building, an opening in the wall is imperative; and this aperture should be fitted with louvre boards, so as to direct the air upwards, the louvres being covered with a hinged lid, to regulate the supply. These should be fixed on such a site as not to make the draught felt by the work-people.

The sketch Fig. 213 shows a still more ornamental article, with the

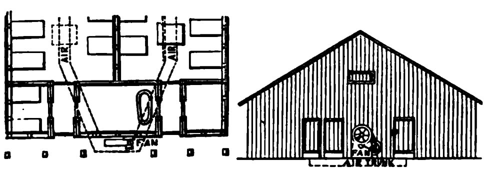
same machinery inside, and is suitable for buildings having some claim to architectural beauty. The hood is here inclosed, and the motion is unseen, though the wind is still of course the motive power. These ornamental ventilators are made in 21, 24, and 30in. sizes, the deal casings being painted stone or oak colour.

The last-mentioned ventilators are not only used to remove the vitiated air in houses, factories, and farm buildings, but they will, in a moderate way, remove the steam and fine dust. In close engine and boiler-houses, in felt factories and carding rooms, and in places where these nuisances are very prevalent, an arrangement is adapted similar to that shown at Fig. 214; and here the ventilator is turned by hand, steam, or other power, with the aid of gearing. These steam-power ventilators are supplied either with or without the wood bases, cast-iron cross beams, footsteps, and driving and guide pulleys. Where sulphurous or other gases are overpowering, or waste flyings unbearable, such a ventilator is indispensable. The action is similar to a fan or blast, but, in comparison therewith as to the driving power required, is about seven-eighths cheaper.

Diameter in inches......		6	8	9	10	12	14	18	21	24	30	36	48
		s.	*s.*	*s.*	*s.*	*s.*	*s.*	*s.*	*s.*	*s.*	*s.*	*s.*	*s.*
Fig. 208*a*		...	28	30	35	45	60	110	...	...	...	...	...
Fig. 209		40	...	80	...	120	...	...	...	...	...	...	...
Fig. 211	Plain...............	25	28	30	35	45	55	88	108	...	...	...	...
	Ornamental......	28	32	35	40	55	65	100	120	...	...	...	...
Fig. 212	Plain...............	28	30	44	49	64	76	118	140	168	222	285	410
	Ornamental......	30	35	50	57	74	86	128	150	183	235	306	440
Fig. 214	Without base and gearing...	...	...	...	...	...	...	...	...	240	290	400	...
	Without base and gearing...	...	...	...	...	...	...	...	...	330	360	440	600

Fig. 210 30*s.* and upwards.

VENTILATION BY FANS OR BLOWERS.



215

Fans, &c., are much used in monster buildings where, during stated

times, thousands of people are brought together. This system requires air passages specially constructed for the purpose, and a special staff of operatives to attend to the fires and machinery. A lengthy description of this process is not desirable in our pages, but fans can be used in buildings of smaller pretensions, and worked by hand. I have used them in Turkish hospitals, in the manner shown at Fig. 215. The arrangement was that of the late Mr. Brunel and Mr. John Brunton, C.E. Each sick ward was furnished with a Lloyd's Rotary Fan, capable of supplying about 1,500 cubic feet per minute when worked by a man—which was, of course, only occasionally, and in the absence of fresh breezes. The air was conveyed along the centre of the floors, and the air inlets to the ward were arranged under footboards, placed beneath the tables. By this *plenum* system instead of *vacuum* system, the entrance of bad air from the closets, &c., at the other ends of the wards was prevented.

The history of ventilation by means of fans, from the date of its first invention by Dr. Desaguliers, in 1734, down to the undermentioned plan of Mr. Marshall would form a most interesting paper, and in some respects a most comical one. Fans are now largely used in all the manufacturing towns. Mr. Marshall's device, which was patented by him in 1870, is for forcing the air into the room with a fan through air-holes in the roof or ceiling, and causing it to escape through apertures near the floor level. He considers this a better method of ventilation than exhausting the air from above. In order to purify foul air, he brings the current first into contact with lime-water, and afterwards passes it through charcoal and cotton wool, thus affording both a chemical and mechanical filtration. If needs be, he can also load the air with a medicinal gas or perfume. As a curiosity, a large room ventilated on this principle would be worth going a long journey to see.

VENTILATION BY FIRE DRAUGHT.

I shall just skim over this division of our subject. There are many different schemes of this class, and, in buildings constructed with special arrangements for the purpose, some of them answer admirably. The latest modification is that patented by Mr. James White in 1867. Here a chamber is formed behind the fire-place, and this is connected with passages leading to the ceilings of a room. The air in this

chamber is rarefied, and in passing off by the flue it takes with it the vitiated air of the room. The foul air passes through the ceiling apertures, and by channels into the air-chamber behind the grate, and out through a pipe in the ordinary way.

At Fig. 216 is shown the system recommended, during 1871, by an

216

architect, Mr. Martin, in a report to the Massachusetts State Board of Health. The room is heated by a stove surrounded by a jacket, which assists in heating the fresh air that pours into the opening under the stove through a large trunk under the floor. The cold air from without is thus well warmed, and rises up within the stove casing to the top of the room, where it is spread along the ceiling, and then sucked down by the action of the smaller ventilating trunks under the desks. These are connected with the chimney shaft, which, for the purpose of heating the air and assisting the draught, contains the smoke pipe of the stove carried all the way up. The outflow of the air is regulated by a valve across the shaft just behind the stove; and should more fresh air be needed, the ceiling lights (shown raised in the plan) invite its entrance. Dwelling-houses, however, can be perfectly ventilated without the complicated systems here described.

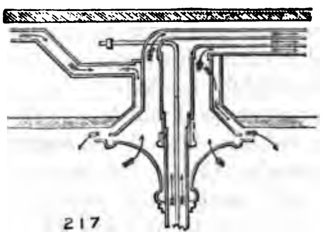
VENTILATION BY PUMPS, BELLOWS, ETC.

Mechanical ventilation of this sort is especially useful in well-digging, when a great depth, say 150 feet, has to be reached, and when the carbonic acid of the workmen's breath stagnates to such an extent at the shaft bottom that the men cannot work. Lime-water may correct the evil somewhat, but it is wisest to give a supply of fresh air at once. A fan would be very useful here; but more than hand-power would be necessary to raise sufficient speed to render the machine effectual. There are several other methods of compassing what is to be done; for instance, a pair of 24in. bellows, with 1½in. pipe, would work satisfactorily to a depth of 200 to 250 feet, and such an appartus would cost about £10, exclusive of the piping. A very useful kind of air-pump is made by Mr. Denny, a well-borer of Bromley-by-Bow, which is intended to be let down in the well for use during any subsequent repairs; and this can be supplied *as low as £4.* It is an air-box of wood, with butterfly valves, and is

connected with a zinc pipe. As it is always wise to have a ventilating apparatus of some kind permanently fixed in the well, some such arrangement as this last-mentioned one is indespensible.

For the readers' guidance who may be sinking wells, and who would rather *hire* an apparatus, I may mention that Messrs. Taylor and Sons, of Newgate Street, London, will let on hire a pair of air-pumps, with 150 feet of lead pipe, at the rate of £5 per month, the rate reducing as the time of loan extends. Messrs. B. Owens & Co., of Whitefriars Street, London, will also lend a No. 50 double-barrel portable pump, with 150 feet of india-rubber and canvas hose, for £2 per week; or a large pair of bellows, and 150 feet of 2in. iron gas tubes, will be lent on hire by Messrs. S. F. Baker & Co., of Southwark Bridge Road, London, for fifteen shillings per week. This is a practical comparison of the different systems in vogue, and is the result of my own experience.

VENTILATION BY CEILING LIGHTS.



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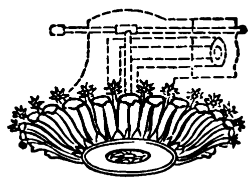

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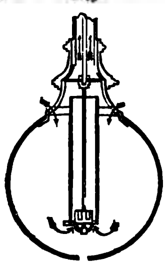
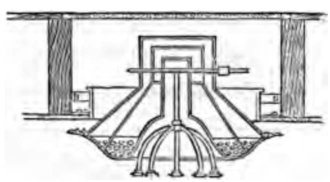




219

This paper would not be complete withou a description of the new ventilating globe light; therefore I give at Fig. 217 a section of that of Rickett's, manufactured by Messrs. Richardson, Slade, and Co.,

N 2

Brownlow Street, London. The action is as under:—An upward draught is created in the main tube directly the gas is lighted, and this rarefies the air in the surrounding tube outside this, near the ceiling. The heated air in both is carried, as will be seen, to the chimney, or to a special shaft; and thus not only is the carbonic acid, &c., removed from the burner, but a sensible impulse towards the chimney or shaft is given to the heated air of the room. A study of the arrowings on the sketch will explain this.

Another useful method of ventilating rooms by the withdrawal of the respired air, and at the same time by the carrying away of the deleterious products of combustion, is by the adoption of the "Sun-burner." The time will arrive when it will be put into use in every factory, save, perhaps, in those where bracketed lights are indispensible to yield a light close to the particular work to be done. Fig. 219 exhibits a sectional view of one when fixed between the joists of a room. The heated air is carried away up the two ventilating shafts at the top of the burner. A view of what is called the Box-top Sun-burner (see Fig. 218) will perhaps still better illustrate the action. This latter pattern is sold for use in small sized rooms, and the hidden portion is of galvanised iron, and is remarkably compact. The exposed portions of both designs are beautifully finished.

Wherever gas is burned a tin or zinc tube should be placed at a proper distance above each burner, and these tubes should convey the products of combustion into the open air. This is, however, so well understood that it is hardly necessary to mention it. Some recommend the tube to be placed inside another so as to effect an exchange of fresh and comparatively warm air, on the principle of the McKinnell ventilator mentioned on page 171. But unless the subject of ventilation has been studied, or it is done first quite experimentally, it would be safer to forego this possible advantage.

Fig. 217, for small rooms, with 12-inch plain globe, 100*s*.
" " large " " 14-inch " 120*s*.

	Diameter of Reflecting Cone.								
	10 in.	12 in.	14 in.	16 in	18 in.	20 in.	24 in.	30 in.	36 in.
jets	6	9	12	16	30	63	72	100	150
	s. *d.*	*s.* *d*	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*
Figs. 218 and 219	45 0	60 0	81 0	111 0	135 0	190 0	240 0	300 0	500 0

CHAPTER XV.

HEATING.

It will be necessary to consider here the different methods of warming rooms; but in order to be practical I shall limit my remarks to the best kinds of open grates, open and close stoves, and conclude with a description of heating by means of hot air, steam, and hot water.

HEATING BY OPEN FIREPLACES.

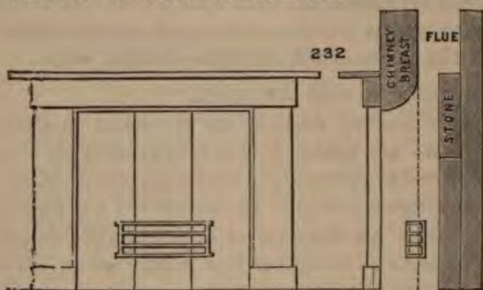
This is the device for heating rooms chiefly patronized in Great Britain and Ireland. We are neither fond of open braziers nor close stoves, like our continental neighbours, and the attempts to popularize them amongst us have signally failed. Dr. Arnott did not succeed during his time in making his close stoves even bearable, despite all the laborious arguments he brought to bear in their favour. The truth is, we have coal to spare and to waste!

When a fire is lighted in an open fireplace, two currents of air are always established in that direction. One of these supplies the fue in the grate with oxygen, and the other passes up the chimney, and causes an influx of fresh air from the outside. This creates a draught fireward, which is sometimes considerable, and at all times disagreeable. A remedy for this has been known in England as far back as 1658. It was the invention of Sir John Winter, and consisted of an air passage, commonly 6 inches square, communicating with the atmosphere outside, and terminating under the firebars. The orifice was closed at will by a door or valve. By this means not only was a sluggish fire made to yield a cheerful blaze, but the heat, when dry wood was consumed, was, by a now obsolete contrivance, compelled to issue into the room through apertures in the chimney breast.

We will not attempt to explain any of the very numerous firegrates now in use, for their name is Legion. There is a description of fireplace, however, known as Count Rumford's, which enables one to more thoroughly utilize the fuel than almost any other, it being now well known that the radiant portion of the heat given off in a common fireplace is but about half the whole heat produced. Fig. 232 illus-

trates a fireplace of this kind, with an opening three feet square, and a space of eight inches between the bottom bar of the grate and the hearth,—this being the proper distance. In setting out a fireplace on this principle, divide the hearth-space into three, and take the diagonal of the two outside squares for the 45° coving of the brick-work. The depth of the fireplace should also be one-third of the opening in front, and the flue in the narrowest place above the fire should not exceed four or five inches.

232



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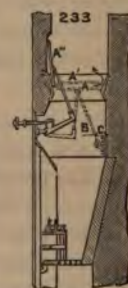


In the *section* will be remarked a large stone which fits loosely in a rebate at the back of the flue; this is removed for the convenience of the chimney-sweeper. Where efficiency, and not appearance is sought, this description of fireplace can be confidently recommended. The grate is merely a set of curved firebars, with a bottom grating, and can be got at any ironmonger's. The fire-bricks forming the coving should be of the best description. Within the last twelve months I have replaced the most costly grates with this old invention of Count umford's.

As more or less copies of the Rumford pattern, the Register grates and stoves of the present day next require mention, but they are too well known to need any description. Besides the univalve register plates, there are, however, now the bivalve registers, sold by Messrs. Lowman, Taylor & Co., London. These are useful departures from the original patterns. Another kindred contrivance is the chimney throat and valve of the late Mr. Billings, now supplied by Mr. Tyler, of Wood Street, London, S.W. The invention is applicable to all fire-places, and may be taken as the best of the many systems introduced *of late years.* Fig. 233 will explain this patent, the use of which is

justly claimed to economise fuel, improve the draught, and also concentrate the heat. The flat position of the valve, of course, hinders the radiation of heat up the flue, as all valves of grates, univalve or bivalve, are meant to do, and, moreover, prevents any great down-draught. When closed, the valve is at A. Its position in ordinary use can be seen at A′; and at A″ can be noticed its place when the machine or hand chimney-sweeper is at work. Besides the above mode of working the valve by a screw in front of the fireplace, we give, in dotted lines at B and C, another way of raising the valve, viz. by a rack and handle. What is supplied by Mr. Tyler is merely the throat valve to fix in the flue, over any grate you may happen to have or to choose. The cost of the screw apparatus is 26*s.*, and the rack and handle 18*s.*

The causes of a *smoky down-draught* are numerous. The chimney may be too large at the opening; it may be too low in height after passing the roof; or it may even be affected by the cold weather if its aspect is due north. The flues may be joined into one another: they may be cracked by settlements in the building, or they may be stopped up by birds nests and like obstructions. The lintel of the chimney piece may be too high, and require an iron or zinc apron-piece, which is an approach to the tapestry fire-cloth of olden times; or it may be too short, and require the opening of the chimney to be contracted. The opening of the fireplace may also be too wide or too high. If there are two fireplaces in one room, the stronger one may be drawing upon the chimney-flue of the other for the air necessary to combustion, and be sucking down the smoke as well as the air. There may be an insufficient supply of air, owing to the door and windows fitting too tightly, and there may be no other entry for the air to feed the fire than down its own vent. The fuel may be of the wrong description for the kind of open stove or firegrate, or, if composed of wood, it may be too green. The doorway may be in the wrong place—nay, for the matter of that, the house may be in a bad situation behind a hill, the wind blowing over the chimnies, to use Mr. Tomlinson's words, like "water over a dam." But likeliest of all, the chimney-pot has been fixed according to contract, and either none was necessary, or it is of the wrong pattern.

It must be conceded that anything wrong is amenable to science, if it be admitted that under certain circumstances it has ever

proved right. There is, therefore, a cure for a smoky chimney. But it is better to call in the architect than the mere smoke doctor. The architect may not be originally to blame. He knows very well that chimneys clustered together, as seen in old-fashioned houses, are the best, because the heat of the one imparts an upcast power to the others, but he has been forced to dot a fireplace here and another there, and leave one altogether out in the cold simply to please his client. I cannot enter into this question further here, but must refer my readers to an excellent series of works upon fuels, fire-places, and smoky chimneys, by Mr. Edwards, published by Messrs, Longman, Green and Co., London.

There is a patent smokeless grate which I will now mention, not because it consumes its own smoke entirely, but because it is a step in the right direction. I refer to the one sold by Messrs. Young Bros., of Queen-street, Cheapside, London. Here the coals are introduced under the ignited fuel, by first being placed in a trough fixed to the lower portion of the open stove front. A right and left handed screw is placed along this trough, and a ratchet-wheel worked by the poker revolves the screw, raises the burning fuel up, and also pushes the fresh coals in the cavity. The same idea is applied to the kitchen range, and not only are the coal, smoke, and gases consumed, but the evolved heat is well utilized.

An improved fresh air cottagers' grate, costing from 30s. to 50s., for warming two rooms with one fire, is now sold by Mr. Penfold, Golden-square, London. This grate is composed of well-burnt fire-clay, and the back part is made hollow, thus forming an air-chamber which receives fresh air from the outside through earthenware pipes. As the fresh air passes through the back of the grate it becomes warmed, and this warm air can be discharged into adjoining rooms.

The idea of heating two rooms by means of the one fireplace is French, and two centuries old. In the French plan, however, the back of the fireplace formed an iron partition, and the second room was heated by radiation merely. In 1713 Cardinal Polignac improved upon the idea, and by means of hollow spaces, which he called caliducts, and which were fed with cold air from the outside, he easily conveyed the air from one room to the other. Mr. Penfold's grate is a vast improvement upon its predecessors in point of *cheapness.* I should even prefer it to those attempts in the same

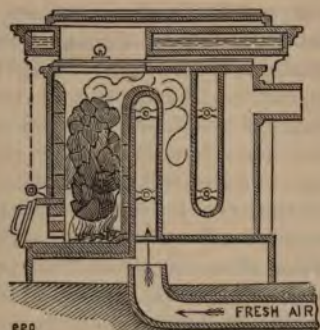
direction made by means of iron chambers behind the fire spaces. But Mr. Penfold is not the first to heat an upper room with the warmed air in this way for the Cardinal specified very plainly how easy it was of achievement.

HEATING BY STOVES.

It is manifestly impossible for me now to enter upon even a short history of the numerous kinds of stoves, from the early rough-and-ready patterns, to the improved systems of Dr. Arnott and others in later days, for this would occupy many pages. For the same reason, I shall make no mention of the Dutch, Swedish, or German stoves. Besides, as they stand, these are unsuitable to our country. What is good in them has also been long ago pirated. The only stoves I shall therefore notice, are those warming and ventilating stoves which are fed by air purposely brought in pipes from the exterior, and I shall select several kinds which have a preference in the market.

The following are most important matters to be borne in mind in connection with these stoves. To begin with: the outer opening of the air-supply tubes should be removed from all sources of bad or impure air, such as, for instance, drains, closets, stables, &c.; and the orifice should also be bell-shaped, and covered with gauze, not only to well distribute the air, but also to protect the trunk from vermin. The only air allowed to feed the stoves should be derived from the open expanse; and if a room exist below the floor on which the stove stands, the air should be brought in air-trunks of wood or pipes of metal between the joists, direct from the external atmosphere,—any draught being excluded by the adoption of such inlet ventilators as those which we have already described. So much, moreover, depends upon the sectional area of the smoke-flues and air-supply pipes being sufficient, that these should be carefully considered, and not put up haphazard, as is too often the case. Soot-doors should also be inserted at the bends, wherever practicable; and, if neglected, this will afterwards be bewailed. The joints of the pipes should also be well made; for, if not, the smoke will escape there, and cause the greatest annoyance. They should, as well, be carefully isolated from the joists, and wood flooring, and walls, by being put in collars consisting of iron or other metal plates. In ascending flues, too, the smoke should be carried to the ridge of the roof by independent pipes, where not very objec-

tionable in the elevation; for I have seen almost endless trouble caused by the pipes being let into chimney flues not suited to command a proper withdrawal of the smoke and gases. As for descending flues,—which are rarely adopted, and then only upon compulsion—the shorter the horizontal part of the flue, the more effectual is the combustion. For fuel, the kind best adapted for stoves of the descriptions I note below is gas coke, although anthracite, turf, or wood can be used. Common coal cakes at the top, and is otherwise objectionable.



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The patent slow combustion stove of Musgrave Brothers, Belfast, is largely used for warming public and private buildings, and is constructed as drawn in section, Fig. 220. The fuel receptacle is lined with fire-clay blocks, easily removed when broken or destroyed; and it accommodates enough to last twenty-four hours, being, moreover, filled through the sliding door at the top of the chamber. The ashes are removed by holding up the door at the bottom, and the necessary air to secure combustion is admitted also between the bars, the ash-box being made to move a little sideways for the purpose. When kindling, the chips are placed at the bottom, and the coke or cinders are heaped above, a light being applied through the front door. As before mentioned, a charge will last twenty-four hours; and, if regularly fed, and the ashes removed, it will burn for a whole year without relighting. In this stove, the products of combustion—viz., the smoke and gases from the fire—are driven through the other two *chambers shown* in the section given; and these auxiliary stove spaces

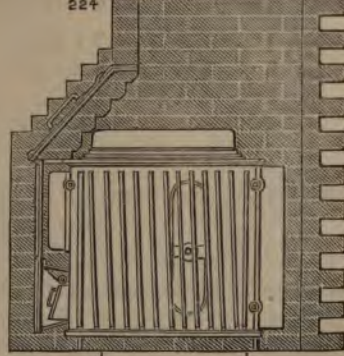
serve to detain these products, on their way to the chimney, until their heat is more completely parted with. The action of the stove is simply thus:—The air enters at the bottom grating, and yields its oxygen to the small fire burning to ashes there; and the evolved heat passes up, and makes the superimposed fuel red hot, which fuel, as it gradually sinks down, and comes into contact with fresh oxygen, is, in its turn, reduced to ashes. Should the fire, from inadvertence, go out, the stove can thus be easily re-lighted, without removing the upper strata of half-burnt fuel.

The above sufficiently describes the interior of the stove; but an external view of one is given at Fig. 221, in order to show the kind of casing which envelopes the stove on the dotted lines shown round Fig. 220. This outside casting is composed of a series of metal ribs, projecting at regular intervals from the stove body, and forming, so to speak, a nest of longitudinal heat cells. Starting up from every available space, these cells or gills rapidly absorb the heat generated by the fire inside, and as quickly give this heat to the cooler air which surrounds them; thus, moreover, avoiding the overheating and burning too common to the old flat-surfaced stoves.

222

223

224



The design (Fig. 221) above is called the rough, slow combustion stove; but, where its plain appearance would be an eye-sore, the ornamental design shown at Fig. 222 is used, the cells being hidden by an artistic-patterned grating. For churches, these stoves are made with

inlayings and brass pillars and crests, the cover being composed of pierced mediæval work. For mansions and large halls, they are also supplied with encaustic surfaces, iron mouldings, and covers of fancy patterns. An ash-pan to accommodate these stoves is shown at Fig. 223; and the ash-pan, as will be observed, sits on an iron base, which is sold independently. In the section given at Fig. 220 will be noticed a vapour chamber, for use in green-houses where a preponderance of moisture in the air is thought desirable.

The above-mentioned patterns represent stoves which stand upon the floor; but a heating medium, on the same principle of slow combustion, is sold, arranged for placing underground, beneath the building which is to be warmed. In this case the apparatus is constructed as drawn at Fig. 224. It is fixed in a brick chamber communicating with the atmosphere outside, and in connexion with flues passing into the room to be heated. When the air surrounding the stove is warmed it traverses the flues; whilst fresh air flows simultaneously into the stove chamber.

An idea of the power of these stoves may be given, by stating that a church 70 ft. by 35 ft., with its high open roof, is effectually heated by a stove 3 ft. 8 in. long, 2 ft. 8 in. wide, and 4 ft. 6 in. high; or, put in a tabular form, it is said that—

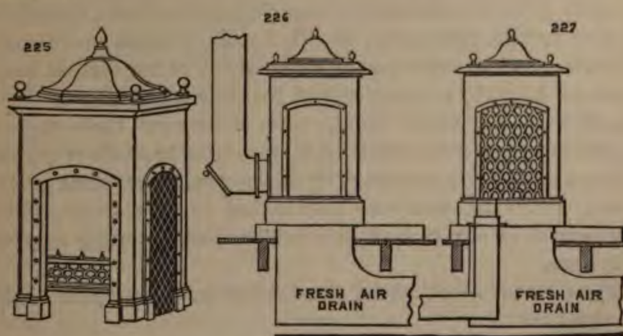
	Size No.	1—1	10 × 1 4 × 3 0	high;	will heat	12,000 cubic feet.
	,, ,,	2—2	1 × 1 9 × 3 2	,,	,,	20,000 ,,
	,, ,,	3—2	4 × 2 0 × 3 3	,,	,,	36,000 ,,
a	,, ,,	4—2	7 × 2 7 × 4 3	,,	,,	45,000 ,,
a	,, ,,	5—3	8 × 2 8 × 4 6	,,	,,	60,000 ,,

a These are the sizes commonly used when the stove is concealed in the basement.

In common with some other stoves of the class, the flue can be made either ascending or descending, the nozzles being fixed at the top, at the back, or in the base below. A stove should, wherever possible, be fixed in the room which it is intended to heat, and should in preference have an ascending flue. But where a descending flue is indispensable, what is called a pilot stove or rarefier ought to be fixed at the base of the upright chimney, receiving the horizontal flue—the lighting a fire in which, before kindling the stove, ensures a commensurate draught in the chimney.

These rarefiers consist ordinarily of a fire space, fitted up with fire and ash doors, and fixed flush with the wall; but Messrs. Musgrave supply a patent close fire rarefier, which not only heats the room it is placed in, but, being built partly into the wall, contiguous to the flue, at the same time compels a draught in the chimney proper. They also manufacture a patent open fire rarefier, which is flush with the wall; but they recommend the close one in preference. The nozzle pipe and bend for connecting the stove with the horizontal flue should be always ordered extra, with a stove with descending flues.

Smoke has been caused partly to descend a flue before entering the main chimney as early as 1678, and in 1860, a vase-shaped iron stove which stood on a box, having a pipe carried upwards into a flue, was exhibited at Paris, and when a current of air was established, by lighting a lamp at the top of this flue close to where it joined the chimney, the brushwood upon the top of the coals was fired, whereupon the flame was sucked downward, in time igniting the coals, and, as Mr. Tomlinson says, "consuming the smoke in descending." In shape this open stove was not unlike an upcurved tobacco pipe, the inhaling of the smoke being represented by the chimney current. Of course, had no current been first established, the result would have nearer resembled what ensues when a pipe is blown into from the mouthpiece.

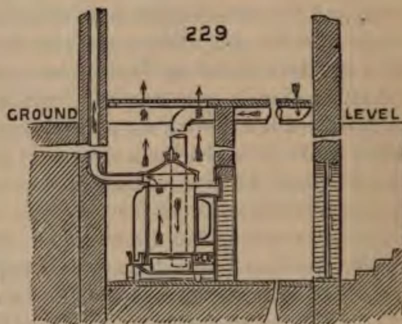


At Fig. 225 will be noticed what is called the patent pyro-pneumatic stove grate, made upon the principle that fire-lumps are the best and purest media for the transmission of heat by radiation.

The air is supplied through a trunk from outside, as shewn underneath the sections Figs. 226 and 227; and the warmth is communicated to the air through the body of the perforated fire-clay lumps surrounding the fire. A stove with an ascending flue is shown at Fig 226, whilst Fig. 227 exhibits a stove with a descending flue. These goods are made and supplied by the inventor, Mr. Pierce, of Jermyn Street, London.

228

229



A stove which commands attention by its efficacy, is what is called the Goldsworthy-Gurney stove, sold by the London Warming and Ventilating Company, Westminster. It is shewn at Fig. 228, and consists of a stove with a plain, smooth, inside cylinder, and a collection of upright wings, cells, or gills for the purposes previously explained. As it is now ascertained that about 25 per cent. of heat is rendered latent by evaporation, and that this latent heat aids largely in efficiently heating the distant parts of the room, these stoves are placed in pans of water regulated to produce the requisite evaporation. The air breathed is, moreover, by this means, never burnt or overdried; and only those who have worked in close rooms, with an ordinary stove always kept to a red heat, can properly appreciate this boon.

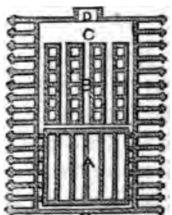
The sizes and capablities of these stoves are given by the vendors as under:—

Size A, 38 inches	exterior diameter,	will warm	120,000	cubic feet.
,, B, 31	,,	,,	70,000	,,
,, C, 25	,,	,,	30,000	,,
,, *D, 17*	,,	,,	25,000	,,
A smaller stove	,,		10,000	,,

or double the above quantity if in perpetual use. The prices are given at page 192.

Fig. 228 represents a stove to be placed inside a room; but if the apparatus is required to be concealed from view, it is inserted under the floor in the manner drawn at Fig. 229, and is equally effectual. The underground arrangement is more costly at first, but, once erected, the heating maintenance is about equal in point of cost.

A plan of a similar stove to that of Fig. 228, but with better developed gills, will be noticed at 229*a*, the invention of Messrs. Smith and Sons, of Barnard Castle, Durham. When the fire-box A is full of heated air and gases, they enter the tubes B. The letter C represents a smoke box, and the products of combustion are forced to pass through this before they escape by means of the stove-pipe D. The arrangement is mostly a repetition of some we have previously mentioned, but here the gills, cells, wings, or laminations, or whatever name they answer to, are unusually large.



229 *a*

	Fig. 221. of Iron	Fig. 222. Iron and plain finish.	Fig. 222. Best Black.	With plain encaustic tiles and bright finish.
	s. d.	*s. d.*	*s. d.*	*s. d.*
Size 1	70 0 *a*	125 0 *b*	145 0 *b*	205 0 *c*
„ 2	110 0	190 0	210 0	320 0
„ 3	130 0	230 0	250 0	390 0
„ 4	210 0		390 0	650 0
„ 5	330 0		700 0	

a With a vapour chamber at top, £4 10*s*. 0*d*. extra.
b „ „ £6 10*s*. 0*d*. „
c With enammelled or majolica tiles, 20*s*. to 60*s*. extra.

		Size 1.	Size 2.	Size 3.	Size 4.
		s. d.	*s. d.*	*s. d.*	*s. d.*
Fig. 223.	Iron base	8 6	15 0	17 6	25 0
	Ash-pan, black	8 6	10 6	11 6	20 0
	Do., Bright-moulded	10 6	13 6	14 6	25 0

Rarefiers, *common*, 35*s*.; *patent close*, 45*s*.; *patent open*, 50*s*. each.
Nozzle-pipe and bend, for descending flue, 15*s*. 6*d*. each.
Fig. 224, exclusive of brickwork, £8 10*s*. each.

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

[illegible]

[illegible] Dr. Franklin's [illegible]

> [illegible]

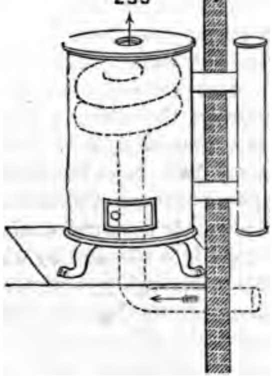
[illegible] from it a stream of warmed fresh [illegible] from a grating in the floor near the side of a [illegible] and the only place allowed for its exit was [illegible] the fireplace—the result would be [illegible] and ventilation. Mr. Lewis, a Government [illegible] this very plan, and finds it work [illegible] If warm air is not desirable, and fresh cold air is sought, then is admitted above the window, and it falls to the bottom, [illegible] the room, and out under the fireplace.

I will now illustrate a stove known as the Calorigen, which, for the most part, carries out Franklin's principles.

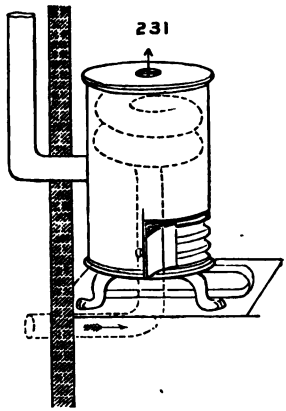
"This it effects by bringing in a stream of warm air, which goes direct to the ceiling is distributed over the upper part of the room, and then comes gradually downward, first reaching the head, and then as it gets heavier flowing to the feet, and out by openings, which, with an open fire, would be a cause of cold draught."

The idea will be seen to be the same both in the Franklin stove and in the Calorigen; but Mr. George, the inventor, also considers that during rarefaction the air drops most of its dust particles, and is thus practically filtered from perhaps deleterious matters.

230



231



Cardinal Polignac may be considered as the father of all these methods of heating and ventilation, and all stoves with caliducts may be said to have sprung from those introduced by him about the year 1713. Mr. George's Calorigen is adapted for burning gas or as an open fireplace. I will first describe the gas Calorigen drawn at Fig. 230. The body of the stove is of thin rolled iron, and is furnished with two pipes terminating in a cylinder, open only at the top, placed outside the wall. The air entering the stove to supply the flame thus comes in contact with the heated air leaving it, and some waste of warmth is avoided. The air necessary to support combustion is, therefore, slightly warme by being diffused through the warmer air, and when used it is carried off with the other products of combustion by the upper short longitudinal pipe. There is no communication whatever between the furnace of the stove and the air of the room.

The most important feature, however, is the introduction of a coil of wrought-iron tubing within the body of the stove, which communicates with the external air below the stove, and is furnished with an opening at the top of the stove. The pure fresh air is therefore warmed in its passage through this worm, but not superheated or burnt, and flows into the room at a moderate temperature. There is, therefore, no necessity for a valve near the ceiling to regulate the exit of any extra hot air, as in the Laconicum of the ancient Romans.

A coal or coke stove on the same principle, except that the air of the room supplies the air necessary for combustion, is drawn at Fig. 231. Fourteen pounds of coal, which seldom costs twopence, will suffice to heat a room fifteen feet square for sixteen hours. It is therefore admirably adapted for the hall of a house, and as a means of heating and ventilating the grand staircase, the more so, as any desired amount of ornamentation can be engrafted upon it. I have fixed both gas and open-fire calorigens, and have never known them to fail in affording an equable warmth joined with an efficient ventilation. Another point is, that the spaces round the doors and windows, when using the gas Calorigen, are converted into passages by which the air passes out of the apartment. This is thoroughly preventive of draughts, and the best cure for these disagreeables that ever I have met with. The cost of the coal Calorigen is six guineas, and the gas Calorigen three guineas, and they are manufactured by Messrs. Farwig and Co., Queen-street, Cheapside, London.

HEATING BY HOT AIR PIPES.

In dealing with the above theme, I do not intend to enter upon the subject of ordinary hot air flues, as they are for the most part perfectly well understood. Hardly an old hot-house but can show the chief faults and chief virtues of this system of heating; and if such a thing is not to be found in cities, some of the public baths will illustrate them. The kind of heating I will shortly allude to is not that small amount of warming which is just necessary to comfortably heighten the temperature of a room, and make it bearable, for that subject has been already considered. Here will be noticed the methods of producing a temperature still more advanced, a desideratum which every one knows is necessary, not only in dwell-

ing houses and horticultural buildings, but in drying and curing rooms and the like.

It would be useless here to explain the working of the hot-blast apparatus, in which the pipes are heated to redness, and the air passed through them by means of a fan or blower at a temperature of over 500° Fahr. This heating by hot air, with a vengeance, is not likely to prove of any service to the householder, who would stand aghast at the amount of waste, and wear and tear, which the system would entail upon him, if performing ordinary work with such a giant hand. For a similar reason, I will not enter upon the warming of rooms by the forcing of the smoke and heated gases through the pipes, instead of hot air. It would be amusing to see the consternation of the serving man, who had received orders to clean out the flues and passages after a few months' working, and had just got far enough into the work to be able to estimate its endless inconveniences.

It must be conceded, to begin with, that heating by hot air is not to be recommended when heating by means of hot water can just as well be adopted. The hygrometric and electric conditions of the air are so altered by its being burnt or dried up, that serious annoyances, and even diseases, have been known to follow an injudicious method of hot air warming. Some physicians altogether condemn its adoption where life is concerned, and have gone so far as to affirm that it is the prime mover in the decomposition of many deleterious bodies floating in the air, the particles of which would be perfectly innocuous if not resolved by this peculiar heat into their original gases,—we mean the Cerberus monster of chemistry, sulphuretted, phosphoretted, and carburetted Hydrogen. Not least objectionable is the close unpleasant smell prevalent about an establishment heated exclusively with hot air on the less improved systems. It is claimed for the Sylvester air-warmer, by Messrs. Rosser & Russell, and for the Gurney stove by the London Warming and Ventilating Company, that these evil effects are obviated by constructing the stoves with gills or ribs, and in such a manner that the diffusing or exterior surface of the apparatus is considerably larger than the interior, or heat-receiving surface.

Another drawback to the adoption of most hot air methods of heating is, that a considerable difficulty occurs in properly regulating the

temperature, as every interference with the fire modifies the heat given out. It is not so with hot water, for there the temperature is limited in its place of working to that of boiling water, and the only essential is the exposure of the proper quantity of warmth-distributing pipe-area. The next fault to chronicle against the system generally is the fact that unless the furnace, which supplies the heat, is *considerably* below the rooms to be heated—unless, in other words, the current of hot air has acquired the requisite amount of velocity to pass it through the necessary horizontal flues—these flat-lying flues will have to be warmed by a special apparatus. In fact, the assistance of a coil of hot water pipes, in these flues, will be indispensable.

In mentioning these strictures upon the system, I am mindful that the evil effects of dried air may be ameliorated by the use of evaporation pans on the stoves, or troughs upon the pipes; and am inclined to believe that in rooms tenanted at any time by living creatures, and so heated, this means of tempering the air to the dried lungs is imperative. Neither do I forget that in some patent methods of hot air warming, a certain economy can be fairly exhibited.

It will be impossible to do more than briefly point out to the reader where the different kinds of apparatus can be got. Should the heating of the laundry, by hot air, be in question, I would strongly advise the study of the different systems of Messrs. Bradford & Co., of Fleet Street; of Messrs. Rosser & Russell, of Salisbury Square; and of Mr. Pierce, of Jermyn Street, all of London. Here can be obtained full information as to the action of the numerous hot plates, drying closets, and iron warmers; and as they differ somewhat in principle, and all differ in construction and are, moreover, adapted to varying conditions of surroundings, the time spent in examining into these methods will not be thrown away. It is chiefly for laundry purposes that this kind of heating is now applied, at least, I for one would limit its use to this branch of home economics. In heating vineries and forcing-houses, it is preferable to have the pits heated by warmed air—that is, by a combination of heated air and naked pipes. To effect this, an underground vault, some few feet deep, is constructed along the whole of the pits, fed with fresh air through air-bricks, fixed close together in the bottom of the side walls, the hot *water pipes* stretching along the top of the arch. This is the best,

cleanest, and most elegant mode of heating these adjuncts to every good garden, and is preferable to heating in the ordinary manner by direct radiation from exposed pipes.

HEATING BY STEAM PIPES.

The only system of heating that can for a moment compare with that of hot water is the system of heating by means of steam confined in suitable pipes. To properly compare these differing systems would, however, be a tedious task, and hardly called for here. The chief advantage in steam over hot water heating is, that less heating-surface is wanted for the former than for the latter. Steam heating can also be advantageously adopted where there is a surplus of steam from the engine boiler, or waste steam from the cylinder of a high-pressure engine. Where the levels vary very much, or a basement floor is especially to be heated, these steam pipes are also very useful. The main objection to heating by steam pipes is, that they give off a disagreeable odour, which cannot be avoided. The supply of steam must also be constantly watched, if efficiency is necessary. The fire under the boiler of a hot water apparatus may almost go out, and still the hot water pipes will retain a fair heat,—in this way condoning the neglect; but if the fire under the steam-pipe boiler languish, the heat will soon become a nonentity. As regards expense it is admitted by most engineers that but little difference exists between the first cost of the hot water and the steam arrangements,—allowing the boilers and pipes to be the best of their respective classes, and the work thoroughly carried out. In the maintenance of the apparatus, however, the economy lies with the hot water system, the boiler there being the only thing subject to wear and tear, and that wear and tear also much under that of the steam boiler.

The best feature about steam heating is that, unlike heating by hot water, the pipes can be made to run in any direction, to and fro, or up and down, the only necessity being that at every new level another outlet is required to be provided, to take off the condensed water. It is, therefore, preferable to have as few sudden dips as possible, a gradual incline in fact with a condensation exit at one place only. This, however, can seldom be compassed. Care should be taken that the condensed water is really removed; for not only will its presence

prevent the steam from filling the pipes, but if the steam is admitted into a cast-iron pipe, part of which contains cold water, the difference in temperature bye-and-bye engendered may speedily cause the pipe to fracture. The condensed water which is run off can either be used over again in the boiler, or made to fulfil most of the uses of distilled water. Professor Gamgee pointed out, the other day, the desirability of using distilled water at the toilette, and the possibility of manufacturing it by the aid of the kitchen boiler. There is no doubt that disease can be conveyed into the mouth even by washing or cleansing the teeth with ordinary water. The use of newly distilled water removes this danger. The idea is one which ought to be practically enlarged upon.

A great source of failure in heating rooms by steam aid is, that unless the air is driven out of the pipes when the steam is laid on, a portion of the pipes will remain cold. To obviate this, a cock may be placed between the boiler and the pipes, and when the steam is laid on, this cock opened; partly shutting it when the purpose is served. In cases where the pipes heat different levels, the eduction pipe should necessarily be placed at the lowest level, the cold air always falling to the bottom. I do not suppose that the reader will ever require an apparatus so huge as to need the services of an air-pump in exhausting the cold air, but this is often found necessary in monster establishments. Great care must be taken with a steam heating apparatus, as any one will suppose, and none should be used until carefully examined by an experienced workman, for an explosion is not out of the sphere of possibilities, even in a moderate-sized supply. As in the case of hot water pipes, and even more so, a proper allowance should be made for the expansion or elongation of the pipes when heated; the joints will otherwise loosen, and even breakage may result. After what was stated under the head of "Damp" in a former chapter, it will not be considered strange if I point out the great necessity of having the buildings to be heated protected from driving or rising wet; it is almost incredible what a vast amount of heat is necessary to evaporate the moisture of damp walls and floors.

In arranging to heat a room, or series of rooms, by means of steam piping, it is necessary to calculate the quantity of pipe and relative size of boiler which will be needful. In this case it will be either necessary to leave it to the engineer, or to consult the published

works of Buchanan, Arnott, Tredgold, or Hood, these being about the only authors who have made heating by steam their especial study, and who have formulated any rules for the guidance of tyros. They are too long to quote here, and are also in such a form as not to endure compression. Dr. Arnott gives the undermentioned memoranda as useful in estimating the extent of pipe and boiler surface, or rather these are the original rules somewhat improved:—

When the external temperature is 10° below freezing point, in order to maintain a temperature of 60°:—

One superficial foot of steam pipe for each 6 superficial feet of glass in the windows. One superficial foot of pipe for every 6 feet cube of air escaping for ventilation per minute. One superficial foot of pipe for every 120 feet of wall, roof, or ceiling.

One cube foot of boiler is required for every 2,000 cube feet of space to be heated; and one horse-power boiler is sufficient for 50,000 cube feet of space. Steam should be about 212°.

85 feet run of 4 in., 108 feet of 3 in., and 170 feet of 2 in. pipe is equal to 100 superficial feet of heating surface.

The above remarks on heating by steam may be concluded by saying that in cases where there is some distanco between the steam pipes in the room and the boiler, the smaller pipe which conveys the steam into the former should be well preserved from condensation on the way, by covering it up with felt or list. In some cases the pipes are inclosed in gratings, but this would be a useless expense in some buildings, and exposed pipes are occasionally otherwise preferable. If covered at all, they need be covered only where contact with them is unavoidable.

HEATING BY HOT WATER PIPES.

This is undoubtedly the best system of heating where an open fire or close stove is objectionable or inefficient. It is also speedily coming into use in places where it was before strenuously objected to. But, as Mr. Richardson says, "its complete success and its economical character depend, in a great measure, upon due consideration of its benefits being given at the commencement of a building."

To begin with the pipes. The obsolete flanged pipe should never be used even for steam heating. The thimble joint will serve the purpose, but nothing can perhaps excel the ordinary socketed pipes. Of course all these pipes require caulking at the joints. Lead must not

be used, as the heat permanently expands it, and the metal will not contract again with the iron of the pipe. Iron cement is now commonly used, but some kinds are apt to expand in time, and burst the pipes. The workmen ought to be questioned as to their knowledge of the safety of the particular cement which they are using. Quicklime and linseed-oil paste is also sometimes used, and here the danger lies in the liability to combustion.

I have lately seen a method of jointing hot water pipes by means of a ring and gland, which might serve a good purpose where the pipes were not exposed in a room, or where the bolts and nuts at the joints would not be objectionable. By this mode a pipe can be cut at any place, and ringed and bolted in a few minutes, and as quickly disconnected; room is also allowed for expansion. The inventor is Mr. Gielgud, of Gracechurch Street, London.

As regards the kind of boiler to be used, I must be excused the terrible task of parading the several scores of these now extant, and fast being added to. One may, however, reiterate the common caution against flat-topped boilers, which retard the ascension of the water. Flat-bottomed ones, in a similar way, impede the flow of the cool water to the middle of the boiler. Multitubular boilers are otherwise objectionable, and the tubular boiler, though it heats a greater quantity of pipe, consumes, at the same time, an out-of-the way amount of firing. Tubular boilers, with hollow furnace bars, are also apt to fill with deposit of one kind and another, and are, therefore, objectionable. For heating small rooms we would recommend either the conical bell boiler, the fire of which burns up the inside of the cast bell, and which is fed by removing the lid at the top, or the Sylvester double conical ribbed boiler, which requires the most simple setting of any boiler extant. For places where more work has to be done, as, for instance, in a large conservatory, I would recommend wrought-iron saddle boilers, of the ordinary arched pattern. For very large premises, the flued saddle boiler will be found the most efficient. The tank boiler and domed boilers are also very economical, but, like the chambered boiler, they are best fitted for *monster* establishments. The unit boiler and the L boiler may also be used with benefit in some cases. The economic boilers of Mr. Ormson of Chelsea, are also well worth inspection. They are made of welded wrought iron, as indeed all boilers should be. The cast iron boilers may be a

little cheaper, but are not so serviceable. Great importance should be paid to the proper setting of the boiler; none but a foreman hand should do this work, and in all cases where the additional cost will not be felt, use Sylvester's air-tight furnace doors, and flue and cleaning doors, instead of those commonly sold for such purposes. These furnace doors slide to and fro, on a gentle incline, upon small brass rollers, and are covered with fire bricks on the inside, to prevent the radiation of heat outwards.

An indispensable matter is the insertion of a valve-cock or small pipe, by way of a vent for the discharge of the air in the pipe. Without this, circulation would be impossible. This air accumulates when the water is cooled, but is not in great presence when the water is kept boiling. The valve, or small let-off pipe, should be at the highest part of the pipes, as air is lighter than water, and is sure to fly there. In cases, too, where it is required to dip under a doorway, it must be borne in mind that the being able to do this depends upon the vertical height of the ascending and descending pipes. Many costly blunders have originated in ignorance of this, and a safe rule is to make the height of the ascending pipe just as high as the dip which it is required to make. There ought also to be a supply cistern, and it is important that it should be level with, or a little over, the highest part of the apparatus, in order to keep it full of water. It must not be too small, as it should be able to contain the water which is sure to return to it when the fluid is expanded by heating it to boiling point. The best engineers recommend that this cistern should hold about one-thirtieth of the whole water in the pipes and boiler.

Something worth remembering is the fact that it is quite immateria how many pipes lead out of or into the boiler, or whether there are more flow pipes than return pipes, or *vice versa*. It is always, however, better to use branch pipes than separate inlets and outlets from the boiler. The main pipe, also, needs not to be of a size in proportion to the areas of the branch pipes, and useless expense has been many times incurred through ignorance of this. It is to be understood, however, that the horizontal leading pipes require to be larger in proportion to the branches than in the case of upright leading pipes. In circumstances where two buildings, somewhat distant from each other, are heated from one boiler, the connecting pipe can be

laid of a very much smaller size than the radiating or room-warming pipes—sometimes even an inch diameter pipe will supply a pipe of four inches diameter. It is best never to heat boilers with gas when it can be avoided, for the expense exceeds that of coals. If you are, however, compelled to burn gas in some cramped place, it may be used in ringed jets, under a copper boiler, shaped on the top like a bee-hive. The great loss of heat in all buildings in which glass is much used is well known, and the same is the case if built with corrugated iron; nor does, as was supposed, the angle of the roof make any sensible difference. The effect of cold winds upon the walls, and of draughts caused by badly fitted doors and windows, need hardly to be pointed out. One word, too, concerning the water to be used; rain water is best, and should be adopted where possible. In the winter time a *little* salt can be added, to avoid the inconveniences which result from ice in the pipes, and the cracking mostly consequent upon thawing. When, however, once filled with salt water, fresh water only need be added afterwards. The little harm that the salt does the pipes and boiler is not worth notice, in comparison with the nuisance which it avoids in the dead of winter. It should also be borne in mind that water which has been boiled freezes sooner than ordinary water.

The following table is copied from Mr. Charles Hood's latest treatise on warming, and will doubtless be found of service to those interested :—

	Ft. run of 4-inch pipe to every 1,000 cubic feet.	Will give a temperature of	Remarks.
Public Rooms	5	55° F.	In cold weather.
Dwelling Houses	12	65°	
" "	14	70°	
Halls, Shops, &c.	10	55°	
" "	12	60°	
Workrooms, &c.	6	50° to 55°	
" "	8	60°	
Schools, &c.	7	55° to 58°	
Linen, &c., Drying Rooms	150 to 180	120°	When empty.
" "	" "	80°	When full of wet linen.
Bacon, &c., Drying Rooms	20	70°	
Greenhouses	35	56°	In coldest weather.
Graperies and Store-houses	45	65° to 70°	
" "	50	70° to 75°	
Pineries, Hothouses, *and* Cucumber Pits.	55	80°	

A ready rule, from the same author, for ascertaining the power of different boilers, is as under:—

To the superficial boiler surface exposed to the direct action of the fire, add one-third of the flue-heated surface, divide the sum by the area of the fire-grate, and the quotient multiplied by fifty-eight will give the quantity of pipe in square feet which can be heated for each square foot of the surface.

Messrs. Rosser and Russell give the under-mentioned rule as a rough means of ascertaining the number of superficial feet of heating surface required in a room:—

Multiply its cubic contents by the number of degrees to which the air is to be raised, and the product divided by 190, and by the time in minutes within which the effect is to be obtained, will give the answer.

This rule will give the extent of pipe necessary to heat the air of a room, but there still remains the question of the extra length of pipe necessary to counteract the cooling effect of the window glass, and the absorption of heat by the wall surface and solid materials. Let us take an example. To heat the air alone of a hall of 160,000 feet, 210 feet of pipe surface will be necessary; but if the glass surface be 800 feet and the wall surface 14,400 more, it will take 606 feet of surface altogether to bring up the temperature of the room from 32° to 62° in two hours.

As a general rule, greenhouses are best heated by four-inch pipes, working-rooms by three-inch pipes, and dwelling-houses by two-inch pipes. The smallest sized pipes are heated more quickly, and give off a greater heat.

For purposes of calculation, I may here repeat that 100 feet superficial of heating surface is equivalent to 85 feet run of four-inch pipe, to 108 feet run of three-inch pipe, and to 170 feet run of two-inch pipe.

Heating by hot water pipes is especially useful in the stable or cowhouse. The best method is to lay two four-inch pipes, one above the other, along the back wall under the manger, six inches above the floor line, and cover over the groove in which they sit with a perforated grating. The feed or main pipes can run along the centre of the passage, and lie in a brick trench, covered with stones, so that ready access can be obtained to them, should any leak appear hereafter. Each section of the building—the stalls, the loose boxes, &c.—can be separately worked, by means of valves, and this is an arrangement better suited for hot water than any other heating.

It will not be necessary to enter upon some other methods of heating by hot water such as, for instance, the tank system, as that is more suited for purposes purely horticultural. It must be understood, however, that where there is not room for pipes to run round a building, or where these would be objectionable, the pipes can be confined to a certain place, and formed into a coil, with almost equal effect. These nests, or coils, or batteries, can be covered over with cast or wrought-iron gratings or inclosures, conveying any amount of architectural gratification to the eye. As mentioned before, the air can be moistened by the adoption of water or vapour-troughs cast on the top of the pipes, &c.; and if a ribbed pipe is needed, where the external exceeds the internal area, as is sometimes recommended where the dryness of the air is disagreeable, Sylvester's triangular ribbed pipe will very well serve the purpose.

The above remarks apply to the *low-pressure* system of warming, such as is usually adopted; but there is a high pressure system as well, which was introduced, and is still practised, by Messrs. Perkins and Son, of Seaford Street, London. In this high pressure system the pipe is made very small, but immensely strong, proved to a pressure of 2,800 lbs. per square inch, and is made with an endless circuit, having, besides, no connection with the atmosphere. The water is heated as high as 300 deg. if needs be, in a number of coils passing through the furnace itself, and this high temperature produces a quick circulation. An expansion tube is placed at the most elevated point of the circulating pipes, and is left empty, so as to yield the requisite space for the expansion of the water when warmed. The system is considered a safe one on the whole, and, if the peculiar smell is not objectionable, can be recommended for heating large dwelling-houses especially. From experiments made, it does not appear to yield any advantage over the low-pressure system in the consumption of coal, but rather the reverse. The only danger likely to arise in adopting the high-pressure heating would occur from the bursting of the coil, either from excessive pressure in the pipes, or the crystalline shortness of texture in the iron. Some little chance of mischief might, though, lie in the high temperature the pipes might impart to anything liable to take fire. As high-pressure steam-heating is a *specialité* of Messrs. Perkins and Son, I should advise the entrusting of this kind of apparatus to that firm.

CHAPTER XVI.

COOLING.

I CANNOT conceive even a healthy home to be thoroughly complete if it lack the means to cool any particular material which may be in requisition. The kitchen may be said to depend upon ice of some sort during those months when the sun is paramount, and when butter more frequently resembles Indian *ghee* than anything else. The dairy and the brewhouse are equally benefitted by the importation of cold at certain times. In health, how refreshing, too, during the summer, is a cooling drink—in disease, how grateful to the aching head is the application of an ice-cold cloth? In the present chapter, I will, therefore, very briefly explain the construction and action of the ice machines, and the formation of ice-wells and ice-houses. These may, however, only interest the wealthy, and I will therefore supplement such explanation by a brief notice of the common freezing-powder machines and ice-chests.

The history of cooling and congelation, by mechanical and chemical aids, is one of the most interesting studies of the present day, and will prove increasingly attractive as time rolls on, and the machine of the future, which is to produce ice at 5s. per ton, is put upon the market. Ice stands to water in something like the same relationship in which repose without somnolency stands to sleep. Both sleep and water are absolute necessities, whilst ice, like mere rest, may be classed as a luxury, or, at all events, as but an occasional necessity.

The power to cool the air of a particular chamber, or substance, or liquid, without proceeding to the length of conglaciation, is, however, also becoming an absolute necessity in these exploiting days, and I will now shortly point out how both this and ice production is achieved by artificial means. No one can eventually be more benefitted than the housewife, by the successive triumphs of our ice engineers.

As an imparter of cold, it must be admitted that ice is the readiest article at hand. How otherwise, with his stunted growth of know-

ledge, could the Eastern hope to bring this dietary and sanitary blessing into his every-day experience? Time was, when the only ice we could muster upon these shores was drawn from our own waters—the nobleman revelling in the clear blocks drawn from his own spring-born lake, and the tradesman enjoying, in a lesser degree, the more impure ice-crusts of the village roadside pond. Ice-houses or ice-wells, in those days, were always items in the domestic foreground, and the former stood like mausoleums in the squires' gardens. Nowadays, however, they are at a many-figured discount, and, if erected at all, are mostly represented by the "ice shades" of the rough ice-dealers who supply the fishermen and the fishmongers. An ice-well of this description, near Islington, for the reception of the cakes collected and carted to it by enterprising hauliers and costermongers during the winter, contains, when full, no less than 3,000 tons, all regelated, by the working of a natural law, into one vast mass.

In place of storing the ice of this country for family use, it is now found more economical to purchase the ice from Norway, which is ploughed and sawn up into large squares when the ice of the far-off lake is about a foot in thickness, and afterwards packed in stores to await the shipper's convenience. It appears that over 100,000 tons of ice were imported into England during 1869, as against 2,000 tons in 1854. The extra cost of the foreign ice, over the home article, is compensated for by its perfect purity of colour, freedom from bad smell, and its consequent adaptability for cooling our aliments by direct contact and immersion, in contradistinction to the indirect cooling afforded by our own coarse and impure article. The refrigerator, of some ten cubic feet, therefore, has already largely replaced the ice-house of a hundred times the size, and the exchange is particularised by increased comfort as well as saving. As a rule, England is supplied from Norway; and America, which formerly, from the old Wenham Lake, shipped block ice hitherwards, has now found more profitable markets in China and the Indies. In Europe, Paris, for instance, is partly supplied with glacier ice from Switzerland; still France has produced a number of useful methods of obtaining artificial ice, which have proved of vast service to her manufactures. More particularly has she applied herself to the *construction* of ice-making contrivances on a small scale, such as

gourmands delight to honour. In Australia, Jack Frost is now also conjured up by the spell of the air or spirit machine, and our American cousins have thus lost another consumer of their lake produce.

The frequent production, in late years, of these ice-making machines, of an intermittent character, for family use, has already exerted an acknowledged influence over the import of block ice from distant countries, and will, doubtless, lead to a distinct preference for the home-made product. The confectionary genius of our Gallic neighbours first gave an impetus to these machines of the more domestic class; and if they have not become general here, and replaced the mere cooling-machines, where freezing powders are used, *it is* because the genius of our country has been occupied with the larger machinery of this kind for industrial purposes—I mean those needed to produce the desirable amount of cold in our breweries, candle factories, soda works, and the like. In a similar manner, the still increasing cost of animal food at home has compelled the attention of our best chemists and engineers to the production of proper cooling-chambers for the reception of the carcases on the voyage home from the Brazils or the Antipodes, the maintenance of frigidity being one thing needful for success.

ICE MACHINERY.

Cooling and ice machinery have been practically divided into two classes. 1st, those in which heat is directly applied in order to produce cold—as, for instance, in the air machines, where the air is first compressed and subsequently expanded; and in the ether machines, where the evaporation is effected *in vacuo*, the speed of the process being accelerated by the use of an air-pump; and 2nd, those machines in which cold is produced by direct heat without the aid of power, as, for example, in the latest Ammonia machine. Each machine has, nevertheless, its partisans, and dire battle is done occasionally; ink has flooded fields of paper, and thousands of broken pens must have strewn the lists. It is claimed for the air machine that it requires the assistance of no chemical agents; that the machinery acts direct upon the air and water; and that it will produce cold air, refrigerate fluids, or make ice continuously as

wished, with the aid of fuel alone. On the other hand, it is claimed for the ammonia machine that more ice or heat reduction can be got out of the coal used by it than any other, the quantity needed being only what will suffice to boil a solution, and that the only power required is that small amount which works the pumps and keeps the cold-conveying fluid in motion. As for the ether machine, it is claimed for it that the construction is of the simplest, that it is cheaper to maintain than any other, and that congelation commences with the first revolution of the flywheel. Outsiders, who are factionaries of no particular maker, would mostly look at freedom from accidents in dealing with the machines—giving preference to the ether machine, where the process is carried on in a vacuum, and the resistance to overcome does not exceed 15 lbs. per square inch, as against three times this amount in an air machine, and ten times this amount in some ammonia machines. Others would judge by the lowest temperature which the invention could register.

Amongst the first air machines were those of Newton & Williams, introduced into notice about twenty years ago. The success of these ice machines led Mr. Kirk, of Glasgow, to study, in its turn, the production of an article for cooling liquids without ice-making, and during the past year he constructed a machine for this purpose, capable of cooling 45 barrels of water at the rate of 15° per hour. the ice-making air machine of Mr. Mignot, of Paris, especial means have been adopted to inject the water in the form of spray into the very midst of the air as it is being compressed in the compressing cylinder. In the air machine of M. Windhausen, of Brunswick, the air is admitted into the compressing chamber as usual, and thence passes into a condenser formed of two series of pipes, whence it enters the expansion chamber to be dilated and cooled. The air then escapes through a valve into the refrigerator, containing the vessels of liquid to be frozen, that is, if ice is wanted, or directly into the room to be cooled, if a reduction of temperature there is desirable. The foregoing represent the most successful machines of the present day for the production of cold by the alternate compression and expansion of the air. Whether the system can eventually be brought into still more economical restraint, depends, we think, mainly upon the improvements brought to bear upon the steam engine itself. For the steam *engine is* a law unto this kind of ice machine.

As the machine of the kind which first attracted notice after Dr. Faraday had shown the possibility of obtaining cold by the liquefaction and subsequent gasification of ammonia, the ice machine of M. Carré, of Paris, demands a mention, not only for that reason, but because it is still peculiarly adapted to ice manufacture on a small scale. With this machine the French waiters are especially conversant, and caraffes of ice and ice creams are produced instanter. It is very surprising that such machines are not common in England. In the earlier ammonia systems of Carré, Tellier, Reece, and others, liquefaction was carried on under pressure alone, but Mr Mort's process, published in 1867, is one of liquefaction by affinity, with the aid of a slight pressure. The most recent ammonia machine which has come under my notice, and apparently the most complete, is the machine patented by Mr. Reece, of London, but it is on too large a scale for the house. The only drawback I can imagine to its use is, that it has to be worked up to an enormously high pressure, and, if imperfectly constructed, would induce a very serious explosion.

The principle of the ether process is the production of cold and of ice by the evaporation of this volatile liquid; but as its tension is otherwise too small, this is carried on *in vacuo*. A machine of this kind also permits the continuous re-use of the ether without loss, provided that the stuffing boxes are kept in perfect order. In Messrs. Siebe's machine the ether is removed by an air pump worked by hand or steam, and the air is then allowed to enter the refrigerator, where it becomes vaporized. It then traverses some branch pipes into the cylinder, and is forced through other pipes into a spiral coil surrounded by water, which acts as a condenser. An air vessel is constructed in the condenser, and sometimes an auxiliary condenser is placed in a bucket outside. In passing through these coils the ether is liquified, and parting with its heat to the environing water, it is returned to the refrigerator.

Professor Gamgee, during the past twelve months, has patented what he considers an improvement on the above kind of machine, viz., the affording a greater area of conducting surface in proportion to the space occupied by the machine; in other words, he constructs his refrigerators and condensers on the tube within tube principle, and obtains a greater cooling power in consequence.

In working both the above machines, the ordinary ether is adopted;

but the latest system of Mr. Tellier is based on the evaporation of an ether produced by the distillation of wood, and is carried on by him at Auteuil, near Paris, with marked success. This machine seems to be able to effect all that a refrigerating machine can effect in the way of ice production, and the maintenance of chambers at 28½° during the hottest summer months.

I have now completed my remarks upon ice machines, but, in order to imbue the mind of the reader with an idea of the value of these machines, I may state that the Windhausen air machine patent for North America was sold for £22,500, and the French patent for £30,000. As much as £10,000 have also been obtained for the right of using the Carré machine in a single Texan Province.

There are in the market of nearly every country some scores of differently constructed machines, varying in price, for the production of ice by the use of freezing powders. But I doubt if they can be recommended on the score of cheapness. Nevertheless, to those who can afford the luxury, the advantages which they confer are considerable. The number of freezing powders is legion; every household chemical work contains, at least, a dozen, and they are fast being added to.

An inexhaustible freezing compound, which can be reconstituted by exposing it in shallow vessels to the sun's heat, when the ultimate crystals, of which it is composed, can be collected, is sold by Messrs. Brown Brothers, and Co., of London, who are also vendors of a series of excellent block ice-making machines, the smallest of which, the "Paragon," costing £3, turns out a half-pound block in eight minutes, and the largest, the "Industrial," No. 4, costing £72, produces fifty pounds of block-ice in half an hour. Cheaper machines than even the "Paragon," are sold for icing creams, and the like, but I need not enter upon them. Of course the cost of the freezing powders rules the question as to whether it is more expedient to make ice in this way than to purchase foreign ice.

The following are some prices of these machines from two London lists—the prices of the freezing compounds vary:—

Name of Ice Making Machine (Brown Bros. & Co.)	Quantity of Ice produced at each operation.	Time required.	Price of Machine complete, with accessories.	The Quantity of Freezing Compound required at each operation.	
				In temperate climates.	In tropical climates.
			£ *s.* *d.*		
Paragon	1 block, 1½lb.	8 minutes.	3 0 0	2lbs.	3lbs.
Utilitarian	1 ,, 1½lbs.	10 ,,	5 14 0	4lbs.	6lbs.
Cosmopolitan.........	1 ,, 2½lbs.	15 ,,	9 9 0	8lbs.	12lbs.
Industrial, No. 1 ...	4 ,, 1½lbs. each	15 ,,	14 14 0	20lbs.	30lbs.
,, ,, 1a..	2 ,, 2½lbs. ,,	15 ,,	14 14 0	20lbs.	30lbs.
,, ,, 2 ...	1 ,, 10lbs.	20 ,,	25 0 0	33lbs.	50lbs.
,, ,, 3 ...	1 ,, 25lbs.	20 ,,	42 0 0	82lbs.	125lbs.
,, ,, 4 ...	1 ,, 50lbs.	30 ,,	72 10 0	160lbs.	250lbs.

Besides the above machines for producing ice there is a kind of combined freezing machine and cooler, which in about eight minutes produces dessert ice, after which anything can be cooled without additional freezing compound or ice. These are known as Toselli's patent machines, and the prices here quoted are those of Chavasse and Co., London.

To take a 1-pint wine bottle, soda water bottle, &c., and to make a quarter pint of dessert ice.. 15*s.* 0*d.*
To take a 1-quart bottle, and to make half-a-pint of dessert ice...................... 21*s.* 0*d.*
To take 3 separate quart bottles, and to make 1 pint of dessert ice .... 42*s.* 0*d.*

ICE WELLS.

The primitive mode of protecting ice was to envelope it in heaps of straw, in such a manner, however, that the moisture could easily drain away. If the surface of the ground is raised to the shape of a flattened cone, then heaped up with about two feet of faggots, a foot or so of good straw added to that, the ice packed conically above these, with a reversal of the process, by way of cover,—or a foot of straw first, a heap of faggots next, and then a thatched roof,—the earliest ice-house is hit off to a warranty. The earlier Italians, like the Persians (and unlike the Spanish, who love snow), patronised ice, and they were accustomed to dig a hole in the side of a hill, constructing a drain from the bottom, which would percolate down the slope without damage, and if the soil were dryish, they did not even line the sides of these somewhat primitive cellars. They, however, believed in a thatched covering, which

they heaped on to an unnecessary extent. In a similar way, many recommend a natural cave for this purpose, where it can be got, as being a place excavated by nature itself: and in pre-adamite times, in all likelihood, stored with most "thick-ribbed" ice. Such caverns are certainly not uncommon in many districts, but like the Margate grotto, are apt to be somewhat too large for a reasonable supply. The modern Italians cover the bottom of their ice stores with chaff, then lay in the ice, which is kept from touching the sides of the pit by a thick lining of chaff, or chopped straw, covering the whole with thatch in the orthodox fashion. Ice will, however, keep for a long time, if merely packed upon stones, and well thatched all round, and on the top, with good wheat or rye straw, to an angle of 45°. The largest stores of ice are the Wenham stores, in Christiana Fjord, which are made to contain 20,000 tons, protected with double walls of timber, and 2 feet of intervening sawdust packing.

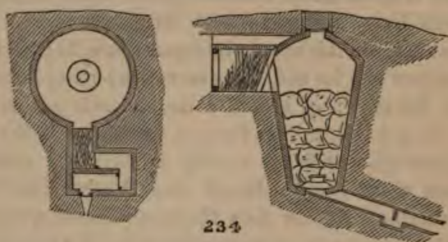
The conveyance of ice to a distance is the most serious part of the performance. The Wenham Lake proprietors, with all their appliances, recognise a direct loss of 50 per cent. In mitigation of the contending difficulties, it was seriously proposed, not long ago, to erect into a trading company a proprietary who would undertake to convey home, by steamers sent to Newfoundland for the purpose, whole icebergs, averaging 10,000 tons each, richly cold and gloriously blue—the deep blue being supposed to appeal to the senses, much as does the green fat of a turtle. But it was doubtless discovered in time that an iceberg below water averages eight times the bulk of the protruding part, and they realized the impossibility of getting it up the Channel.

Before commencing to describe any of the systems of storing icef there are a few necessary cautions and rules to be observed. Amongst others the following:—Avoid a clayey soil if possible, and choose a dry, sandy, gravelly or calcareous one for your ice-well, and having fixed upon your design, begin with a single wall, taking precautions that will enable you to construct a second, or even a third wall, with vacuities between; for it frequently happens that people on discovering their icewell to be faulty, abandon it, when, likely enough, another enclosing wall would have set the matter right. Be particular to drain the bottom of the well, which should in no case be flat shaped, and insert a dip-trap in such drain, to prevent the entrance of atmospheric air, with its melting influences. Moisture, as well as

heat, is, however, a great foe to ice conservancy, and especial care should be taken to convey to some distance from the ice-well or house the rain-water which falls in the vicinity. The admittance of rain-water into a well has been known to raise the temperature there to 60°. For a similar reason, the well should be kept from moisture, by sufficient ventilation, that is to say, the top, the bottom, and the wall, should be kept free from sweating dampness. At least three, and sometimes five doors (only one to be open at a time) should be constructed in the passage, which, if convenient, may be made tortuous, although this is by no means a necessity, and these doors, for patent reasons, should have a northern aspect. Earth also being a better conductor of heat than air, it is wise to interpose straw, heath, or some such material between the ice and the excavation; exceptions occur, but they are far between; of course a double wall renders this unnecessary. Do not believe that there is any virtue in the shape of a well; a square one will serve equally as well as a round one, an inverted cone shape being adhered to—all other conditions being equally favourable. Neither does the worthiness of a well consist in its depth; there cannot be a greater mistake; for no well, unless it should be wanted to supply a whole city, like the one mentioned at page 206, should exceed 20 feet from the surface of the ground. The ice-well or ice-house should also be enveloped by the shade of trees,—non-deciduous if at all possible. Better to trail ivy up the mound of an ice-well than leave it bared to the sky. Avoid stone in building an ice-store, and choose bricks, and next to that, walls of timber. Lastly, as regards the filling up between the walls or timbers, it is not necessary to be very particular, so that the material is well rammed home. Chaff, straw, chopped straw, sawdust, ashes, charcoal dust, powdered coal, turf, heath or furze, all these will serve the purpose. When it can be afforded, a most excellent lining for between-walls will be found in the compressed coal such as is made at Swansea; a compound kind, made in Belgium, is used for this very purpose, by the *Compagnie des Glacières de Paris.*

When filling the ice-well, store away the first ice of the season, taking care it is free from dirt, and above all from snow. In stowing it in the well, avoid mixing it with the straw, as this will render it very porous. Choose also as clear a day as possible upon which to cart home the ice; and when dealing with pond ice, break up the

cakes with a mallet to a coarse powder, and ram it well down, throwing a little water upon it occasionally to facilitate congelation. Some sprinkle the ice with salt and water, 1lb of the former to one gallon of the latter, out of a watering-pot, at intervals of two feet up to the top, pouring on an extra quantity when the well is filled up. This cold water treatment makes the ice so solid that it will yield to a pick-axe only, and an ice-well should always be built sufficiently wide and shallow to admit a man with such an instrument. The top of the surface, too, should be left a little concave.

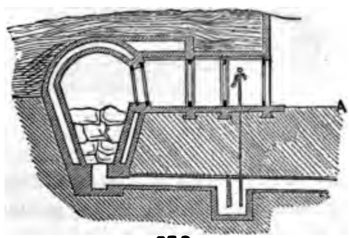


234

The first scientifically constructed ice-house I suppose to be that which was designed by Mr. Blackburn, about 1778, and of which I give a sketch at Fig. 234. It consisted of a wedge-shaped excavation, (which form he first of all appears to have adopted) and the site chosen was the side of a hill. The sides were built of steined brickwork, well-fashion, without mortar, and filled up behind with gravel, brickbats, loose stones, &c., so that the water would drain legitimately to the well bottom. This surface water, and the melted waste water, ran down a sloping drain, trapped, it will be noticed, a certain distance down, so as to exclude the outer air. The ice was put into the well through an aperture in the crown, and this aperture was covered by a door fitting into a rebated frame, next to the inside of the dome. When this door was closed down, the whole was heaped over with earth. From the sloping door down to the threshold of the passage, the space was filled with straw; and the form of this passage can best be seen upon the plan, being in fact, a short labyrinth, with treble doors.

Such was, to the best of my knowledge, the first ice-well built upon the principle of the inverted cone; but some time afterwards Mr. *Loudon published* a palpable improvement upon the plan of Mr.

Blackburn, which we give at Fig. 235. This may be considered the model upon which are built most of the best outdoor ice-wells in our country seats. The natural surface of the ground is shown at A; and in England it would be necessary to heap two or three feet of earth over it, whilst in hot countries eight or ten feet would be desirable. The walls and the arched roof, as will be observed, are built double; but even a third vacuity, and an extra large well space, would be requisite in climates less temperate than our own. An improved form of entrance is here contrived, fitted up with five doors, the two nearest the well mouth being closer together than any of the rest. The passages inside the secondand third doors are intended to be fitted up with shelves of slate or stone, upon which to cool liquids, or keep viands from heat and decay. A small pump is fixed in the first porch, or passage, and communicates with a well or enlarged trap in the drain of the ice-house, the ice-water being very valuable for cooling, if not for drinking purposes.



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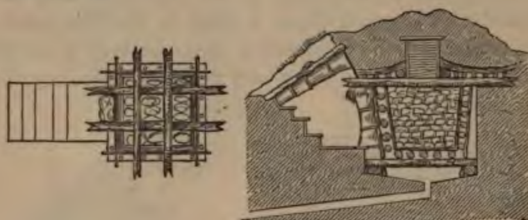
Another form of ice-well, and one found equally satisfactory, as far as ice preservation is concerned, but hardly possessing the number of advantages of the last mentioned plan, is that given by Mr. Ure, and engraved at Fig. 236. It is a double cone in shape, the two cones being joined base to base; and otherwise differs by having solid walls, and a timber roof, covered with thatch. Great care is here taken to convey the rain to some distance, and so prevent soakage. When being filled, a quantity of long dry straw is laid across the bottom, and this material is also spread against the conical sides, to prevent the contact of the ice with the bricks or stone. When full, a thick bed of straw is laid down, and upon that, boards and heavy stones. The average width of the above ice-wells at the widest part is 14 feet.

Mr. Gordon, in constructing an ice-well, excavates much more ground than is necessary for the ice which it is to contain. This ice-receiver is a house framed of strong timber, boarded roughly outside, and lined inside with straw set erect, and confined with laths nailed to the main timbers, after the style in which moss is confined in the interior of some old summer-houses. This structure is built up in the excavation, and the surrounding space is then filled with heath, gorse, brushwood, or tops of firs. This roof is also made of a conical shape, and neatly thatched with heath or straw, covering in the building proper, and also the extra-mural space between that and the surrounding earth.



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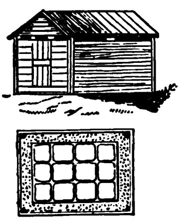
An American pattern of ice-well is drawn in plan and elevation at Fig. 237. A square hole, six feet deep, is dug in the ground, care being taken to construct a drainage way for the melted water. Two timbers are placed along the sides, and two cross timbers are then nailed across these. Upon them are laid some laths about two inches in diameter, and these are confined between the main uprights. The smaller scantlings filling up the sides are now nailed to the standards, and, when built up, four beams, ten feet long and about six inches diameter are laid across the top. On these smaller timbers are crossed, to receive the dead weight of the earth. To the inside of the well, and upon the ceiling joists of the roof, a lining of straw, three inches thick, is affixed by way of a non-conducting surface. The aperture for filling the well is situated above it, and resembles a small box. It is lined throughout with board, and filled up with straw before the earth is heaped over the well. The entrance for withdrawing purposes is considerably narrowed at the doorway at the

foot of the steps, and here, before the door, is placed a large bundle of straw. Besides this door, a trap-door is formed at the surface of the well, somewhat on an incline, and this, when covered with straw on the inside, completes the arrangement. In carrying out this kind of well in Germany, it has been found expedient to line the outside of the well with straw, as well as the inside, and to make the filling-in box at the top somewhat larger. In that country they also spread plenty of straw on the surface of the ice. A well of the above dimensions, made in the way shown, ought to contain about four tons of ice, and cost something under £15 sterling.

It must not be supposed that, because I have only figured ice-wells with the earth heaped over them, that they cannot be made ornamental in appearance. On the contrary, the most consummate taste will here find a congenial subject; and on the Continent many of the finest pavilions owe their very existence to the necessity for ornamenting these wells.

ICE HOUSES AND COOLING ROOMS.



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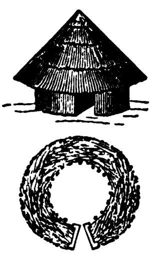

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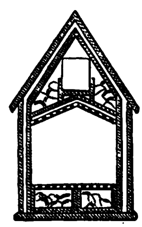

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The simplest form of ice-house is that which is mostly in use in North America, and known generally by the name of an ice shanty. A plan and elevation of one is given at fig. 238. The walls are usually single, especially when the ice can be packed block fashion in the centre, and the space between, of a foot in width, is well packed with sawdust, chaff, or finely chopped straw. A similar thickness of the same material covers over the ice when packed into the hut. The doors are best made in two heights, so as not to expose the lower blocks

until absolutely needful to do so. The air is allowed the freest circulation over the top of the non-conducting material, through the air holes left under the eaves.

In a London Mechanical Journal of 1869 there was recommended the following novel and cheap ice-house. It is constructed as drawn, in plan and elevation, at Fig 239. Twenty-eight posts, nine feet high, by six inches square, about eighteen inches apart, form the interior ring, and thirty-eight posts, five feet high, by five inches square, about nineteen inches apart, form the outer circle, the space between the two being about four feet. This space is compactly and smoothly laid with rye or wheat straw, and the whole conically roofed over and thatched. The foundation for the ice consists first of round logs, eight inches diameter, laid across the area with intermediate spaces of a foot in width; across these are placed poles about four inches diameter, six inches apart; then rods two inches diameter, transversly over these, and about three inches asunder. Upon this are spread dry twigs or strong heath, and a doorway being formed, the house is ready for its wintry guest.

A very good design for an ice house thatched similar to Fig. 239, and with sawdust walls, was given in the *Queen* for January 13th of this year.

It is estimated that in America, during the hotter seasons, many thousands of pounds' worth of fruit are lost by reason of early decay. A low temperature is found to check this incipient decomposition, and an ice fruit-house to secure this benefit was invented by Mr. Parker some years ago, a section of which we give at Fig. 240. It is built of wood, and the space between the outside and inside linings is filled with sawdust, or some other non-conductor. The ice-chamber is below the floor, and this floor is not a close-boarded, but an open-battened one. At the top of the house, and forming a V-shaped ceiling, is a double inclined floor, and under this is a wire screen, a space being maintained between the screen and the floor. On the highest part of this upper floor sits a narrow piece of flooring, with upright sides, and holes or traps occasionally formed in the same, through which the fruit is let down and hauled up again. Ice is, moreover, packed on the top of this upper floor. The only extra care required to be taken is, not to open the trap-doors in the gable passage without *previously closing* the outside door, which admits the fruit-man.

241

242

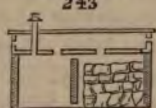
At Fig. 241 may be noticed an ice-house which is said to be much appreciated on the Continent. Several sleepers, resting upon a well-rammed bed of tan or coal-dust, support several planks crossed above them, but with sufficient spaces between for the water to run off. The standards are about four inches square, and form the framework, and these are cased inside and outside with oak planks. A quantity of charcoal powder is well pressed down between the studding, and a straw lining is also secured to the inside boarding of the house, as shown. A second wall is then built around this structure, which is also lined outside and inside with oak planking, and similarly stuffed with powdered charcoal. The entrance is at the roof, and leads to a passage with two doors, the inner one being shown open in our sketch. The roof itself is well covered with straw.

The uncertainty of dealing with ice is well illustrated in this example. Some have found it to suit very well as it is; others condemn, as I should, the air space between the two walls as quite unnecessary, and even faulty in principle. But it would be certainly impossible to design an ice-store which should please every one. All these buildings have their faults at first; and the person who expects to construct right away a *perfect* one, will find that he has undertaken a task almost equal to that of building a place warranted to echo. The echoing galleries were all the result of accident, and we believe that all *perfect* ice-wells and ice-houses have had similar fortuitous parentage. There will always be a little alteration wanted here and there, but once got right, it will last the allotted time of the material of which it is constructed.

I may as well describe here an ice house which is considered very satisfactory in parts of Prussia for the cooling of drinks. This is illustrated at fig. 242. A large iron-hooped, barrel-shaped receptacle is

let into the ground, say in the floor of a cellar, and is packed all round with about six inches of ashes. The barrel is constructed with a double bottom, with holes or slits in the upper one, and a pipe conveys the ice water collected upon the true bottom of the barrel into a bucket, where it is ready to be withdrawn, for culinary or other uses. This bucket lies at the bottom of a well, as shown. The barrel itself is closed with a lid, cushioned round the flange, and this lid is filled with ashes, and is hung by a rope, which passes over two pullies, with a counterbalance. In filling the barrel, a round pole is first put down the centre, and the ice well broken round it, and then withdrawn, leaving a cold air channel. The only improvements to be made on this plan are the substitution of chopped straw for ashes, and the placing of the barrel upon a substratum of straw.


243


244


245

It is sometimes desirable not only to store the ice for ordinary domestic uses, but in order that it may communicate a cool atmosphere to an adjoining room. For instance, one method of cooling a milk-room is exhibited at Fig. 243. The ice is piled up over head on a galvanized iron flooring, which is cooled by this means almost to freezing point, and the cold air in descending speedily depresses the temperature of the room below. The ice floor is inclined to the centre, and the water as it melts flows off into a discharging tube, in which is formed a flat syphon trap, thus preventing the warm air outside from attacking the ice.

Fig. 244 illustrates another method of communicating the cold to a milk-room; and here the ice receptacle is upon the same level as the *cooling*-room. The partition dividing the rooms has openings both at *the top and bottom*, and these keep up a constant current of air upon

the ice. The larger these openings are made, the more cool will the room become,—but, of course, at the expense of the ice; the openings are, therefore, fitted with closures, and the closer or more open position of these doors or closures is regulated by a thermometer. Ventilators are also fixed in the ceiling, which open when fresh air is needed to replace the foul air whisked away by the ventilating pipe. Both of the above we copy from the *Albany Country Gentleman*.

At Fig. 245 is exhibited a more elaborate American ice-house, with a cooling-room below. In the centre of the walls are trussed timbers placed four feet apart, which are meant to support the open battened floor, upon which the ice is placed; and to the bottom of this truss are attached iron sheets, which form a ceiling to the top of the cooling-room. This ceiling inclines from the centre each way, and the ice water is collected in the two longitudinal iron troughs immediately underneath the trusses. The space between the top and bottom beams of the truss forms a cold air chamber; but it must be borne in mind that apertures are left in the centre and at the sides of this iron casing. The soffit of the topmost ceiling is covered on the under side with boards, and on these loose shavings are heaped some eight or ten inches thick. A ventilator with louvres is formed along the ridge, and within the walls are flues which eject the air from the cooling room into the external atmosphere. The ice in the loft is not quite packed up to the ceiling, neither is it allowed to touch the walls of the loft. The action is as follows:—The warmer air in the cooling-room rises through the apertures in the centre of the trussed ceiling, into the intermediate or cold air chamber, and impinges upon the ice, when it becomes cooled, and falls back into the cooling-room through the apertures above the interior guttering. The fresh air enters the gable or attic space above the ceiling of the ice loft, and divides itself as it cools through the chinks of the boards and shavings into the space between the ice and the top ceiling, passes then over the surface of the ice, and descends along the sides of the same through the open battened floor of the loft into the cold air chamber, and thence into the cooling room where it is utilised. The extra foul air escapes through the flues into the side ventilators above the eaves.

By this means the cool air from above and around the ice is compelled to descend into the cooling room on the ground floor, and the equilibrium of pure air is preserved by a continual influx from the

atmosphere outside. The refrigerating room may be even flanked by other cooling rooms, and cold transmitted into them. I need hardly say that the ice-chambers of all these cooling-rooms require replenishing from the ice-well or ice-house, as their contents successively disappear. I give the above descriptions merely to show what has been done with ice in the way of reducing the temperature of a room. In a very large establishment, it would be cheaper to erect a small ice machine.

ICE CHESTS AND REFRIGERATORS.

I have nowhere yet alluded to the ice-chest, neither is it my intention to describe any one of the scores now in use, since their construction must be known to all. I question, however, if the very best article for this purpose has yet been produced.

A very good system of an ice-chest, to be built in the floor of a cellar, is given by Dr. Menzel, of Prussia. It is merely a dovetailed wooden box, let into the ground, and the bottom of it covered with straw, upon which the ice tablets or blocks are laid. The ice is then covered with a double layer of cocoa nut or Manilla matting. The ice and its covering is only allowed to reach half-way up the box, and the rest is appropriated for the storing of whatever it is wished to cool. Proper precaution is taken to guard against contact with the earth, by interposing a suitable non-conductor, and the lid is constructed with especial care. This kind of ice-chest can also be made to stand *upon* as well as in the ground, but it is, of course, a little costlier.

I append below the prices of the commoner ice-chests, also the more improved ones fitted up with ventilators. These prices are taken at random from two London lists.

Common Refrigerator or Ice Box. (*Chavasse & Co.*)

Long.		Wide.		High.		Prices.		
ft.	in.	ft.	in.	ft.	in.	£	s.	d.
1	10	1	9	2	4	3	3	0
2	2	2	0	2	5	4	4	0
2	8	2	1	2	7	5	5	0
3	3	2	2	2	8	6	6	0
3	5	2	5	2	9	7	7	0
4	0	2	8	3	2	10	0	0

IMPROVED VENTILATED ICE CHEST, PROVISION PRESERVER, AND WINE COOLER, Fitted with Block Filter and Tank for Drinking Water, and the Improved Ventilator.
(*Brown, Bros., & Co.*)

Wide.		Deep.		High.		Prices.		
ft.	in.	ft.	in	ft.	in.	£	s.	d.
1	6	1	6	2	4	7	0	0
1	6	1	8	2	6	8	0	0
1	9	1	9	2	9	10	0	0
2	0	1	9	3	0	11	10	0
2	3	1	10	3	3	13	5	0
2	6	2	0	3	6	15	0	0
2	9	2	2	3	9	16	10	0
3	0	2	4	4	0	18	0	0

PRESERVATION OF SNOW.

Snow is evidently preferred to ice in Italy, Spain, and Portugal, for cooling purposes; and in the last mentioned country, when a deep gulf or rift of snow is discovered in some suitable place, a quantity of grass and sods are thrown over it, heaping this over again, a foot or so in depth, with dung from the sheep-pens. Snow thus preserved has been imported by the rude and slow conveyances of the country into Lisbon, from a distance of nearly two hundred English miles. In fact, if snow be well compressed, and nothing but snow admitted into the reservoir, it will serve most purposes equally as well as ice. We read that when Alexander the Great wished to enjoy the luxury of refrigerated drinks, he also used snow; and it is upon record that on a certain campaign he caused at least thirty trenches to be dug, which he filled up with snow, and covered with branches of the oak.

According to Plutarch, the Ancients used to preserve the snow by covering it over with chaff or coarse cloths. This snow was, we suppose, used in cooling their wines. To go so far back in antiquity as 1000 B.C.,' Solomon also mentions its usefulness as a cooling medium. Ice, however, is so nearly universal, that more remarks on this head would be superfluous. There might arise a necessity for the packing away of snow in districts where plains abound, and in this case we would treat it much in the same way as we treat ice;—beating it well down into the reservoir, taking care to leave no cavities in which to engender heat—sprinking plenty of water over it during

the stevedoring into the hold of the well—lining the vault with chaff, and covering it with a double quantity of good thatch.

I have now concluded the task which I had set myself. I have endeavoured on all questions pertaining to my subject to give the best information, and the results of the most recent enquiries. My object has been to write a popular treatise which shall embrace all the sanitary requirements of a modern habitation, and to offer the result of my labours in this direction in a work at a price within the reach of everyone.

INDEX.

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